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CONTENTS:

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*THE IMPORTANCE OF ASTROPHYSICAL RESEARCH AND THE RELATION OF ASTROPHYSICS TO OTHER PHYSICAL SCIENCES**

THE domains of the physical sciences are not, like the political divisions represented on a map, capable of being defined by boundary lines traced with mathematical precision. They pass into one another by imperceptible gradations, the unity of nature opposing itself to rigid systems of classification. Thus there often exists between two allied sciences a broad ground, belonging to each, yet exclusively the property of neither, which may be so extensive and fertile as to justify the development of a new science for its special cultivation. And such a science not only subserves the purpose for which it was created, but it has the further special importance that, by promoting an exchange of knowledge between its previously established neighbors, by investigating the cause of disagreements between them, by comparing their methods, and possibly by detecting errors in their results, it tends to bring them into more perfect coordination.

Such is the nature of the science which Professor Langley has called the new astronomy, and which is also, and perhaps more generally, known as astrophysics. Its

*Address delivered at the dedicatory exercises of the Yerkes Astronomical Observatory, of the University of Chicago, Williams Bay, Wis., Thursday, October 21, 1897.

high development has in fact been so recent that its name is found in only our latest dictionaries. It is closely allied on the one hand to astronomy, of which it may properly be classed as a branch, and on the other hand to chemistry and physics; but it assumes wide privileges, and it is ready to draw material which it can use with profit, from any source, however distant. It seeks to ascertain the nature of the heavenly bodies, rather than their positions or motions in space—*what* they are, rather than *where* they are; and for my own convenience I shall use the terms astrophysics and astronomy to denote the sciences of which these aims are respectively characteristic. Yet here again the line of demarcation cannot be sharply drawn, since the measurement of celestial motions that cannot be dealt with by the methods of the older astronomy is one of the most important tasks of the astrophysicist. That which perhaps is most characteristic of astrophysics is the special prominence which it gives to the study of radiation. The complex nature of white light, in particular, is never lost sight of, and its consequences are thoroughly exploited.

That the older astronomers made no efforts systematically to study the nature of the heavenly bodies, is to be ascribed to the seeming hopelessness of such an attempt in their day, rather than to a lack of interest in the subject, or a slight appreciation of its importance, on their part. They did, in fact, seek explanations of such phenomena as they could observe, and the beginnings of astrophysics are to be found far back in the past. But the curious speculations of Sir John Herschel on the structure of the sun's photosphere show how inadequate was the supply of facts to serve as a basis for a science of solar physics in Herschel's time. The conception of living organisms a thousand miles long, floating about on the sun's surface, and shining with the intense brilliancy of the photosphere, seems to us extraordinary, and even grotesque. To lose its strangeness it has to be considered with reference to the contemporary state of knowledge. But the fact that only fifty years ago it was regarded as an admissible supposition by one of the most eminent of astronomers helps us to realize how rapid has been the advance of astrophysical science. It was only after the discovery was made, that the light which reveals to us the existence of the heavenly bodies also bears the secret of their constitution and physical condition, that the basis for a real science was obtained. The spectroscope placed new and hitherto undreamed-of powers in the hands of men. It is to the astrophysicist what the graduated circle and the telescope are to the astronomer.

The study of astrophysics does not at present seem to have a very direct bearing on the practical affairs of everyday life. If to this statement the objection should be made that the study of solar radiation is likely to lead to a practical method of utilizing the sun's heat as a source of mechanical power, I should say that such a discovery (if it is ever made) is much more likely to be the result of an ingenious application of principles already known. What the future may have in store we cannot tell, but at present the statement I have made holds good. With respect to practical usefulness, therefore, astrophysics does not possess the same claims to consideration as astronomy, which has obviously important applications in furnishing standards of time, and in surveying, geodesy and navigation, and in addition to these, an immense indirect influence on thousands of ordinary affairs. Yet on such grounds it is not probable that any astronomer would care to base a claim for his science. Astronomy long ago reached that state of perfection which suffices for the practical ends

I have mentioned, and is still pursued with undiminished vigor. Both astronomy and astrophysics take their stand on a higher plane, where it is a sufficient justification for their existence that they enable us better to understand the universe of which we form a part, and that they elevate the thoughts and ennoble the minds of men.

In considering the importance of astrophysical research, I have, therefore, regarded the question from a purely scientific point of view. Even with this restriction there is room for a considerable diversity of opinion, since the elimination of the human element from the question is impossible. Scientists are men. Every man is naturally inclined to attach special importance to that in which he is himself specially interested. Personal preferences, or even prejudices, may enter into the estimation in which a branch of learning is held. But, setting these aside, there are grounds for differences of opinion which are entitled to respect. What importance is to be attached, for example, to the proof, now brought almost within our grasp by the improvement of spectroscopic instruments and methods, that the law of gravity is operative within the stellar systems, as well as in the system of our own sun? Doubtless there are some who are satisfied with the moral certainty that we already possess, and to whom the proof just mentioned would merely afford the satisfaction of inking in, on a printed form, the penciled words which had already been written in its blanks; while there are others who would regard the formal proof as alone entitled to consideration. I have even heard widely different opinions expressed by eminent astronomers as to the scientific importance of a problem so fundamental as the exact determination of the distance of the sun.

The degree of importance which we attach to a newly discovered fact or principle is influenced by many circumstances, among which we cannot fail to recognize some of the failings of human nature. When progress is rapid, individual achievements lose their prominence, like mountain peaks rising from a high plateau. The discovery of an asteroid was once a notable event. Now it attracts little attention, outside of a small circle of observers, and it is probable that few of us could say just how many of these little bodies have been brought to light during the past year. In astrophysics discoveries of the highest significance have succeeded one another so rapidly that they are now taken as a matter of course.

The bearings of a discovery on existing knowledge are sometimes not immediately perceived, and its true scientific importance is not appreciated until these are revealed in the fullness of time. Other circumstances might be mentioned, but these are sufficient for my purpose, which is to show that there is no cause for surprise if opinions differ as to the exact value of astrophysical research. It is because the science of astrophysics is so young—so distinctly in the formative stage—that I have ventured to discuss a question which, in due time, will settle itself.

A feature of astrophysical research which I do not wish to leave unmentioned is the interest which is felt in it by the public. Those who are interested in the results of science, but who care little for methods, and know nothing of elegant forms of analysis, are naturally more attracted by the view of the heavenly bodies which astrophysics presents than by the view which is obtained from the standpoint of the older astronomy. Astrophysics paints its picture in the brighter colors. A star regarded as a center of attraction, or as a reference point from which to measure celestial motions, awakens little enthusiasm in the popular mind; but a star regarded as a sun, pouring out floods of light and

heat as a consequence of its own contraction, torn by conflicting currents and fiery eruptions, shrouded in absorbing vapors or perhaps in vast masses of flame, appeals at once to the popular imagination. Both branches of astronomy share in the advantages which follow this awakening of popular interest; for that popular interest in any science is to be deprecated is to my mind utterly inadmissible. The cultivation of a pure science is possible only in those communities where such an intelligent interest exists. Without it we should not be here to-day. It is splendidly manifest around us. The only possible danger to be feared is that interest in results whose significance is readily understood may lead to an undervaluation by the public of results which are of the highest importance, but which only the trained specialist can fully comprehend; and this danger will be avoided if scientific men publicly express their own appreciation of results which belong to the latter class.

Popular interest which is not of this character, but which has no purpose other than amusement, is less desirable. "It is the universal law," says Macaulay, "that whatever pursuit, whatever doctrine, becomes fashionable, shall lose a portion of that dignity which it had possessed while it was confined to a small but earnest minority, and was loved for its own sake alone." Macaulay is here referring to a temporary interest in scientific matters which prevailed among fashionable circles in the reign of Charles the Second—to what would now be called a 'fad.' In our own time science occasionally suffers in much the same way. It is to be regretted that the habitability of the planets, a subject of which astronomers profess to know little, has been chosen as a theme for exploitation by the romancer, to whom the step from habitability to inhabitants is a very short one. The result of his ingenuity is that fact and fancy become inextricably tangled in the mind of the ay man, who learns to regard communication with the inhabitants of Mars as a subject deserving serious consideration (for which he may even wish to give money to scientific societies), and who does not know that it is condemned as a vagary by the very men whose labors have excited the imagination of the novelist. When he is made to understand the true state of our knowledge of these subjects he is much disappointed, and feels a certain resentment towards science, as if it had imposed upon him.

Science is not responsible for these erroneous ideas, which, having no solid basis, gradually die out and are forgotten. Thus it cannot long suffer from outside misapprehension, while the sustained effort necessary to real progress is in the end a sufficient safeguard against the intrusion of triflers into its workshops.

In astrophysics sustained effort is as necessary as it is in other branches of science. There is an impression in some quarters that the results of astrophysical investigation are easily obtained. That this is in some cases true may readily be admitted. I cannot regard it as a reproach. It is one of the advantages to which I have referred by bringing new methods to bear on old problems. What an effort to grasp something tangible we observe in the earlier writing on Fermat's principle! What a groping in the dark after a principle felt rather than seen! and how obvious the same principle is from the point of view of the wave theory! In a field so wide and so little explored as astrophysics there must be novelties which can be gathered with comparatively little effort, and which may nevertheless be of no small importance. But there are also problems whose solution calls for the exercise of the highest intellectual faculties, and for the most strenuous exertion.

In astrophysics difficulties are met with

quite different from those of physical astronomy. There a vast variety of highly complex phenomena are to be referred to the operation of a well-known and extremely simple law. The mental discipline there obtained is of the highest order, and it is hardly necessary to say that a training in the methods of the older astronomy should be regarded as an indispensable preparation for astrophysical work. But in astrophysics, as in the sciences of chemistry and biology, there are difficulties which arise from an imperfect knowledge of the laws governing the phenomena observed. The discovery of unknown laws and principles, as well as the explanation of phenomena by laws already known, is one of its most important objects.

I have referred to the differences of opinion which usually exist with reference to the value of a new science. There may be some who view with disfavor the array of chemical, physical and electrical appliances crowded around the modern telescope, and who look back to the observatory of the past as to a classic temple whose severe beauty had not yet been marred by modern trappings. So mankind, dissatisfied with present social conditions, looks back with tender regret to the good old times of earlier generations, yet rushes forward with the utmost speed. May we regard the eagerness of pursuit as a measure of the value of its object? That the importance of astrophysical research, considered with respect both to its own ends and to its bearing on the advance of knowledge in other fields, is already great, and that it will grow steadily from year to year, is naturally my own belief. In a general way I have considered some of the reasons on which it is founded, and I now wish to call your attention to a few specific cases which illustrate my general remarks, and in which I think the importance of astrophysical science is manifest.

Some of the most noteworthy advances in astronomy and in astrophysics have been made possible by the introduction of photography. The photographic plate not only gives a permanent record of what the eye can see, but, by its integrating power continued through long exposures, it builds up a picture from light impulses too feeble to affect the sense of vision. Thus it has been discovered that vast regions in the sky are filled with diffuse nebulæ, which (since the apparent brightness of a surface cannot be increased by any optical device) must ever remain unseen. This information, which the photographic plate alone could furnish, is itself most wonderful and suggestive. It is, however, but a part of what the same plate may yield. Whoever has studied Professor Barnard's admirable pictures of the Milky Way in Scorpio must have observed how accurately the distribution of the smallest stars corresponds to that of the extended nebulosity which fills this part of the sky, and at the same time how strikingly the nebulous matter is concentrated around the brightest stars in the constellation. Bright stars, faint stars and nebulosity are unmistakably physically related, and, hence, at the same order of distance from the earth; and from this it follows that the real sizes of the stars are of entirely different orders. Here is a fact having a most important bearing on the question of stellar distribution, brought out by the simplest possible means. It is perhaps beyond the reach of more elaborate methods. And in this case it is to be observed that the evidence would not be made clearer by any further treatment of the material. The positions of the stars and the density of the nebulosity might be measured, and the results might be tabulated, but all to no purpose; for, if the data yielded by observation were in the form of measurements, the first step toward their interpretation would be the construction of just such a

chart as the photograph places ready in our hands.

Of very great importance to the new astronomy has been the investigation of the conditions of maximum efficiency of its chief instrument, the spectroscope, by the methods of physical optics. The theory of resolving power, introduced by Lord Rayleigh, and quite recently elaborated by Professor Wadsworth, has been especially fruitful. It has done away with the old idea that the efficiency of a spectroscope is measured by its dispersion, and may be trusted to destroy in time some musty traditions concerning the magnifying power and definition of astronomical telescopes. The theory has also been extended so as to include the spectrograph, in which the photographic plate takes the place of the eye at the observing telescope of the spectroscope. The designing of spectroscopes has thus been placed on a thoroughly scientific basis. At the same time the demands for accuracy in the practical construction of the instrument have been greatly raised. The objectives, the prisms, the fitting of the mechanical parts, must be the best possible. Hence the spectroscope has become an instrument of precision, worthy of a place among the most refined instruments of practical astronomy, and fitted for the class of work now most needed in astrophysical research.

A familiar example of the mutual obligations of allied sciences is found in the first measurements of the velocity of light. Perhaps a somewhat parallel case may have to be recorded by the future historian of science. Spectroscopists have tested the validity of what is known as Doppler's principle, by which the motion of a body in the line of sight is determined from the observed displacement of its spectral lines, and have at the same time proved the capabilities of their instruments, by means of the velocities of the earth and heavenly bodies furnished to them by astronomy. It is not impossible that this also is a reversible process, and that measurements of the velocities of bodies in the solar system may give one of the best methods of determining the dimensions of their orbits.

Numerous cases could be mentioned in which astrophysical investigations have contributed to our knowledge of the chemical elements. Of these the first which naturally presents itself is one of the most recent. The element helium was discovered first in the sun (as its name implies), then in the stars, then in the nebulæ, and at last, by Professor Ramsay, it was 'run to earth.' It had an important place in celestial chemistry long before it was known to terrestrial science; and, on account of its rare occurrence and seeming inertness, it is quite possible that but for the spectroscope of the astrophysicist we should have remained forever ignorant of its existence. To the astrophysicist, however, it was known only by the occurrence in its spectrum of one bright line. Laboratory investigations soon revealed its complete spectrum, and then the astrophysicists were able to recognize, as belonging to helium, a large number of lines whose origin in the heavenly bodies they had been unable to discover. Our knowledge of the heavenly bodies may be greatly advanced when the properties of this remarkable element shall have been thoroughly studied.

It is not necessary, however, to seek illustrations in new elements. The complete series of hydrogen lines, to which belong the few lines that are ordinarily seen in the laboratory spectroscope, was discovered by Huggins in the spectra of the white stars; and a new series, which had previously been seen by the eye of theory only, and which, so far as I know, has not yet been produced artificially, has recently been found by Pickering in the spectrum of the star *Zeta Puppis*.

Another familiar element is calcium. Its

ordinary properties are well understood. But under the conditions met with in the sun and stars it behaves in a mysterious manner. Notwithstanding its considerable atomic weight, it floats quietly high above the surface of the sun, where other heavy metals are only occasionally present in consequence of violent eruptions. It is true that the apparently abnormal spectrum of calcium under these conditions has been shown by Sir William and Lady Huggins to be merely the result of extreme tenuity of the luminous vapor; but the existence of calcium at such great heights, under any conditions whatsoever, seems to point to some remarkable property of the element which is unrecognizable by the methods of ordinary chemistry.

The spectrum of a substance is not the same under all circumstances. In some cases a change occurs suddenly when certain critical conditions are reached; in others the change is gradual and progressive. By studying these changes in laboratory experiments, and comparing them with what we see in the observatory, we are able to arrive at some definite conclusions respecting the conditions which prevail in the stars, while the same comparison often throws light on the phenomena observed in the laboratory. It has been shown, for instance, that the spectrum of magnesium gives a means of estimating the temperatures of the stars; and the same criterion enables us to recognize in the stars temperatures vastly exceeding the highest that have been produced on the earth. Thus the science of astrophysics allows us to extend our investigations to temperatures which the resources of the laboratory cannot furnish.

It may be well to mention an example of the difficulties, to which I have referred, arising from our imperfect knowledge of the laws which underlie phenomena constantly observed. Recent comparisons of the spectra of the sun and metals, made at the Johns Hopkins University with the concave grating spectroscope of Professor Rowland, have proved that spectral lines may not merely be widened by increased pressure of the radiating vapor, but that they may be shifted bodily; while the still more recent investigations of Zeeman show that a line may be widened (and at the same time doubled) under the influence of a strong magnetic field. It is true that in both cases the effect produced is very small. It could not lead to mistakes in identifying stellar lines, or to appreciable errors in measuring celestial motions. But the fact that the spectrum of a substance varies according to circumstances which are as yet only imperfectly understood, shows us the necessity of exercising caution in interpreting the spectral phenomena presented to us by the heavenly bodies. At present these spectral variations increase the difficulties that the astrophysicist has to contend with. Eventually they will become additional and most valuable sources of information.

The discovery, by Kayser and Runge, of line series in the spectra of the common elements has a most important bearing on the work of the astrophysicist. It provides him with the means, long greatly needed, of deciding with certainty whether or not lines in celestial spectra are identical with lines in the spectra of terrestrial substances. On the other hand, as we have already seen, he is sometimes able to supply the physicist with missing data.

From the point of view of the old astronomy the most important result of the introduction of the new methods has been the determination of motions in the line of sight by means of the spectroscope. The method has been tested so often, and with such uniform success, that there is no longer any doubt as to the correctness of the principle on which it is based, or to the accuracy of the results which it is capable of yielding

in competent hands. It is directly applicable to one of the great problems of astronomy—the determination of the direction and rate of the sun's drift through space. From the proper motions of the the stars, furnished by the methods of the older astronomy, the direction of the sun's motion can be deduced, and, under certain assumptions as to the stars' distances, the rate of motion; but it is evident that the latter element of the problem must be subject to very considerable uncertainty. With the spectroscope velocities are directly measured in miles per second. The two methods may be combined. It is probable that the most accurate determination of the *direction* of the sun's drift can be obtained by preparing proper motions, while the most accurate value of the *velocity* is that given by the spectroscope. Thus by the coöperation of the two branches of astronomy, there is measured in space a base line of constantly increasing length for a great sidereal triangulation. At present the material afforded by spectroscopic observation is not sufficient for this great work. The observations must be treated statistically, and statistical methods can be applied successfully to only a large mass of data. What is now needed, therefore, is observations of more stars, *i. e.*, fainter stars, and the German government is building a large telescope for the observatory at Potsdam (where photography was first applied to this class of observations), in order that the work may be continued. There is room, however, for the employment of other large telescopes in the same field. The multiplication of observations for this purpose is no more to be deprecated than the multiplication of observations for the exact determination of star places.

Solar physics, from which the wider science of astrophysics has been evolved, offers problems so numerous and so complicated that I cannot even mention them, still less enter into a discussion of their bearing on other branches of knowledge. And what can I possibly say of their importance? The sun is to us the grandest of material objects. It is the source of practically all our light and heat; of practically all our mechanical power; absolutely the support of all our lives. What wonder that we seek for knowledge of its nature by all the ways that we can find! These ways are opened through astrophysical research. In few of the inquiries that I have referred to can the method of light analysis be dispensed with. In most of them it offers the only chance of success.

I have time to mention only one new method of solar research. The most notable contribution to solar physics within the last few years has been the invention of the spectroheliograph by Hale and Deslandres. With this instrument photographs of the sun are taken by strictly monochromatic light, which may be chosen from any part of the spectrum. If the part selected is the middle of the K line, the picture essentially represents the distribution of calcium vapor on the disk of the sun, and the presence of other elements is ignored. This is, in fact, the line usually chosen, partly on account of the conspicuous rôle played by calcium in solar phenomena, and partly for other reasons, which it is not necessary to state. The possibilities of the method are obvious. By an ingenious modification of his instrument Hale now photographs on a single plate the Sun covered with all its spots and faculæ, and surrounded by all its prominences; and all this is done in a few minutes, in full daylight! Could the corona be added, the triumph would be complete; but the corona yet remains unconquered in its stronghold, though the attack is being vigorously pushed.

No branch of observational astronomy seems to be in so backward a state as the

representation of the surface features of the planets. Although the moon has been photographed with splendid success, and the planets with results that are encouraging and suggestive, we still rely (in the case of the planets) on the old method of hand drawing used by Galileo. The fallibility of the draftsman is well known. It has been illustrated again and again. Yet there seems to be a curious habit among some observers of regarding a drawing, when once made, as invested with high authority —as that of a standard established by legislative act. A photograph, if it could be made, would be free from the errors of the draftsman, and from a personality which is recognizable in all hand drawings, and which, though it is scarcely to be classed as an error, it would be desirable to avoid. Here, then, is another opportunity for the new methods. There is no reason to suppose that it is impossible to obtain photographs of the planets which will show all that the eye can see, although there are many reasons to know that it will be very difficult to do so. The instruments for this purpose would have to be quite different from those in general use, and there would be few occasions, in even the most favored regions of the earth, when they could be employed. Difficulties would also arise from the rapid rotation of some of the planets. But this is not the place to discuss the necessary conditions. It is only fair to say that Professor Schaeberle, of the Lick Observatory, has already been experimenting in this direction—with what success is not yet generally known.

Passing to stellar spectroscopy, a field broader even than that of solar physics is opened before us; for the sun, although paramount in his own system, is only one of the stars. In a general way, the spectra of the stars have been observed, and classified according to their character, and objects of unusual interest have been noted for future investigation—many a rare specimen has been meshed in Harvard's widely extended net; but the detailed study of individual spectra has just begun. For this purpose large telescopes are desirable, if not absolutely necessary. Many observations of precision required in the older astronomy are best made with small telescopes. But in stellar spectroscopy light is all-important; and while much can doubtless be accomplished with small telescopes, there is probably nothing that cannot be done better with large ones. Even in solar spectroscopy, where the supply of light is abundant, a large image is required for the study of individual parts of the sun's surface.

No department of astrophysics has profited more by the introduction of photographic processes than stellar spectroscopy. To the advantages of photography already mentioned there is here to be added another not less important. Owing to atmospheric disturbances the image of a star dances about on the slit-plate of a spectroscope placed in the focus of a telescope. The spectrum is not only faint, but tremulous, and to measure the lines in it by visual observation is like trying to read a printed page irregularly illuminated by flashes of light. These irregularities do not appear on the photograph. They disappear in the process of integration. Negatives obtained with the spectrograph can be directly measured under a microscope, or enlargements can be made from them in the usual manner. In this way photographs of star spectra are now made which are comparable, with respect to accuracy and wealth of detail, to Kirchhoff's famous map of the solar spectrum. "It is simply amazing," says Professor Young, with reference to the Draper memorial photographs, "that the feeble, twinkling light of a star can be made to produce such an autographic record of substance and condition of the inconceivable distant luminary."

Let us consider for a moment some of the questions in this field that are open for investigation. The motions in the line of sight of all stars within reach of the largest telescopes have to be measured. This important line of research has already been referred to. The relation has to be ascertained between the various classes of star spectra and the probable order of stellar evolution. It now appears practically certain that all the stars are not made according to a single pattern, and that they cannot be fitted into a single scheme of development. The Wolf-Rayet stars, the stars with banded spectra, the stars with bright-line spectra, the planetary nebulæ, the spectroscopic binaries, the variable stars, require the most careful attention. Variables of the Mira class should be followed with the spectroscope as far as possible from their maximum, and the spectral changes which accompany the light variation of other stars, whether due to phenomena of emission and absorption, or to relative motion of bodies in a revolving system, should be studied with the most powerful instruments.

The discovery, by means of the spectroscope, of binary stars which are far too close for resolution with our most powerful telescopes, and which are recognized in their true character by a periodic doubling of their spectral lines, has brought to our knowledge strange and wonderful conditions of orbital motion. Such a system as that of Spica, where two bodies like our sun revolve around each other like the balls of a gigantic pendulum, in a period of only four days, at a distance no greater than that which separates the sixth satellite of Saturn from its primary, must have remained forever unknown to the older astronomy. Between these spectroscopic binaries and the most rapidly revolving doubles visible in the telescope there is a wide gap, the cause of which is obvious. The conditions favorable to discovery in the two cases are directly opposed, and doubtless a large class of stars lies at present just beyond the reach of either method.

But this gap may be bridged over by means of such a great telescope as we see before us to-day, while the work necessary to accomplish this end will open up still another field for research. It has long been recognized that the position micrometer and the spectroscope, taken together, are theoretically competent to determine the real orbits in space of the components of a double star; hence, also, the masses of the components and their distance from the earth. Until recently the question had only a mathematical interest. But the small velocities to be expected in the case of any double star whose components can be separately distinguished with the telescope are now almost, if not quite, within reach of the spectroscope, and the investigation of such doubles has acquired a physical interest.

Here I must close my review of the important questions before the astrophysicist, with the consciousness that it is most remarkable for what it leaves unnoticed. I have said nothing of questions relating to the photography of comets and their spectra, the rotation of the planets or the absorption spectra of their atmospheres, the colors of double stars, the spectra of temporary stars, the measurement of obscure wavelengths; nothing about stellar photometry, the application of interference methods to spectroscopic research, the exploration of the infra-red spectrum. But I will not trespass further on your patience. In all the fields that I have mentioned there are noble problems, worthy of the best efforts that can be given to their solution. To realize their importance, think how ill we could spare what we have already won. What a blank would be left in our knowledge of the heavens if the results of astro-

physical research in our own generation were stricken out!

The future should look bright, indeed, as we view it to-day. Munificence and skill have provided this splendid observatory with means for promoting knowledge in both the older and the newer branches of the sublime science to which it is dedicated. Its magnificent equipment will be used by men who have won merited distinction in both the older and the newer methods of research. It has the cooperation and support of a great institution of learning. From this happy union of ability and opportunity we have reason to expect results of the highest import to the new astromony, and to its allied branches of physical science.

But, lest any words of mine should give rise to expectations that may not be fulfilled, I wish to say once more that important results are not necessarily of a striking or surprising character. We can hardly assume that every increase in telescopic power will be followed by the discovery of new planets or satellites. Such discoveries, if they come, will be welcome; but they should not be expected. There may be no more planets or satellites, yet undiscovered, in the solar system. But we may confidently expect from the work of this observatory those results which throw light on the dark places in nature, and which, therefore, though they may not stimulate the popular imagination, are of the very highest importance, for they are indispensable to true scientific progress.

JAMES E. KEELER.

ALLEGHENY OBSERVATORY.

MATHEMATICS AND ASTRONOMY AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE officers of the Section of Mathematics and Astronomy were as follows: Chairman, W. W. Beman; Secretary, J. McMahon; Press Secretary, P. A. Lambert; Councillor, E. W. Hyde; Sectional Committee, W. W. Beman, J. McMahon, A. Macfarlane, W. F. Durand, J. E. Kershner, W. S. Pritchett; Member of Nominating Committee, A. Ziwet; Committee to nominate officers of Section, W. W. Beman, J. McMahon, A. Hall, Jr., R. S. Woodward, A. Macfarlane.

The Chairman's address was on 'A Chapter in the History of Mathematics,' which has already been published in this JOURNAL.

The following papers were presented to the Section:

1. A Problem in Substitution-groups. By Dr. G. A. Miller, Rosette, Kan.

2. Continuous Groups of Spherical Transformations in Space. By Professor H. B. Newson, Lawrence, Kan.

3. The Treatment of Differential Equations by Approximate Methods. By Professor W. F. Durand, Ithaca, N. Y.

4. Commutative Matrices. By Professor J. B. Shaw, Jacksonville, Ill.

5. On the Theory of the Quadratic Equation. By Professor A. Macfarlane, Lehigh University, South Bethlehem, Pa.

6. A New Principle in Solving Certain Linear Differential Equations that occur in Mathematical Physics. By Professor A. Macfarlane, Lehigh University, South Bethlehem, Pa.

7. Condition that the Line Common to $n-1$ Planes in an n-space may Pierce a Given Quadric Surface in the Same Space. By Dr. Virgil Snyder, Ithaca, N. Y.

8. The Psychology of the Personal Equation. By Professor T. H. Safford, Williamstown, Mass.

9. Compound Determinants. (Preliminary communication.) By Professor W. H. Metzler, Syracuse, N. Y.

10. Waters within the Earth and Laws of Rainflow. By W. S. Auchincloss, C.E., Philadelphia, Pa.

11. On the Secular Motion of the Earth's Magnetic Axis. By Dr. L. A. Bauer, University of Cincinnati, Cincinnati, O.

12. Simple expressions for the Diurnal range of the Magnetic Declination and of the Magnetic Inclination. By Dr. L. A. Bauer, University of Cincinnati, Cincinnati, Ohio.

13. The Theory of Perturbations and Lie's Theory of Contact-transformations. By Dr. E. O. Lovett, Princeton, N. J.

14. On Rational Right Triangles. No. I. By Dr. Artemas Martin, U. S. Coast Survey, Washington, D. C.

15. Some Results in Integration expressed by the Elliptic Integrals. By Professor James McMahon, Cornell University, Ithaca, N. Y.

16. Modification of the Eulerian Cycle due to Inequality of the Equatorial Moments of Inertia of the Earth. By Professor R. S. Woodward, Columbia University, New York.

17. Integration of the Equations of Rotation of a Non-rigid Mass for the case of Equal Principal Moments of Inertia. By Professor R. S. Woodward, Columbia University, New York.

18. General Theorems concerning a certain class of Functions deduced from the properties of the Newtonian Potential Function. By Dr. J. W. Glover, Ann Arbor, Mich.

19. The Importance of adopting Standard Systems of Notation and Coordinates in Mathematics and Physics. By Professor Frank H. Bigelow, U. S. Weather Bureau, Washington, D. D.

20. A Remarkable Complete Quadrilateral among the Pascal Lines of an Inscribed Six-point of a Conic. By Professor R. D. Bohannan, Columbus, Ohio.

21. Stereoscopic Views of Spherical Catenaries and Gyroscopic Curves. By Professor A. G. Greenhill, Royal Artillery College, Woolwich.

No. 1 pointed out that to every simple isomorphism of a group to itself corresponds some substitution of its operators; and that to all such isomorphisms corresponds a substitution group, which has been called the *group of isomorphisms* of the given group. A new and simple proof was given of the following theorem of Jordan's: When a regular group (R) of order n is transformed into itself by the largest possible group (L) of its own degree, the subgroup of L which includes all its substitutions that do not contain a given element is the group of isomorphisms of R. Other theorems were proved regarding those isomorphisms which may be derived from a given one by means of real transforming operators.

In No. 2, of which a brief abstract was read by the Secretary, the general group is that of Lie's Kugelgeometrie. All infinity in space is regarded as a single point and all planes as spheres through the point at infinity. The general group is tenfold. All transformations leaving a point invariant form a sevenfold sub-group. There is a sixfold subgroup which leaves a sphere invariant, and which is identical with the sixfold group of circular transformations on the Neumann sphere or in the complex plane.

No. 3 was read in joint session of Sections A and B. It showed how to compute successive values of a function defined by a differential equation without solving the equation analytically. Using Newton's notation for derivatives of y as to x, and indicating successive values of y by subscripts, the simple trapezoidal rule would serve to express approximately the difference between $\dot{y}_0$ and $\dot{y}_1$ in terms of $\ddot{y}_0$ and $\ddot{y}_1$, and similarly that between y_0 and y_1 in terms of $\dot{y}_0$ and $\dot{y}_1$. Hence $\dot{y}_1$ and y_1 may be ultimately expressed in terms of y_0, $\dot{y}_0$, $\ddot{y}_0$, $\ddot{y}_1$. Substituting their values in the differential eqnation, the latter will give the value of $\ddot{y}_1$. This value substituted back will give values of $\dot{y}_1$ and y_1, and hence the quantities for the point 1 are completely

known when those for the zero point are assigned; and so on from point to point. The trapezoidal rule may be replaced by more accurate rules if desired. The method is applicable to equations of any order, and also to simultaneous equations.

No. 4 showed that if two matrices are commutative, *i. e.*, if $\varphi\psi = \psi\varphi$, then there is no latent system of any root of the one which lies in the extension composed of two or more latent regions of a root of the other unless it includes the entirety of these regions. The case when one of the matrices has equal roots was developed.

No. 5 presented a new theory of the quadratic equation $x^2 + 2bx + c = o$; stating that when b^2 is greater than c the roots may be either real numbers or 'hyperbolic complexes,' and that when b^2 is less than c the roots may be either 'circular complexes' or scalar numbers. In this view the square root of negative unity can in certain cases be interpreted as a scalar instead of a versor.

No. 6, which was read in joint session, showed by an example that when one term in the differential equation is the orthogonal projection of a plane motion, it is in some cases easier to pass to the auxiliary motion by means of 'planar algebra' than it is to proceed with the given equation directly. (See Trans. A. I. E. E., Vol. X., p. 186.)

In No. 7, of which the Secretary presented a brief abstract, there were $n - 1$ linear equations and one quadratic equation in the same n variables, and the problem was to determine when the simultaneous values of the variables that satisfy these equations are all real. The criterion obtained has applications for $n = 2, 3, 4$ or 5, whether the generating element be a point, a plane, a line or a sphere.

The object of No. 8, which was read by the Secretary, was to awaken an interest among astronomers and psychologists such as to induce them to pay more attention to the work of each other and thus improve their own methods where necessary.

In No. 9, which was presented in abstract by Dr. Shaw, the idea of obtaining the value of $A(m)$ the m^{th} compound of the determinant A, as a power of A by multiplying it by its adjugate $A(n-m)$, the $(n-m)^{\text{th}}$ compound of A, is extended to finding the value of certain minors of $A(m)$ in terms of A and its minors. By making use of a comprehensive notation the whole subject is unified, the laws of vanishing minors set forth, and such well-known theorems as Sylvester's and others are easily established.

In the absence of the author No. 10 was read by title, and a printed pamphlet was distributed in Sections A and B.

An abstract of No. 11 was presented by the Secretary. It stated that about 70 per cent. of the total magnetization of the earth can be referred to a homogeneous magnetization about a diameter inclined to the earth's rotation axis by an angular amount of about 12°. This axis has been termed by Gauss the earth's magnetic axis. It is an interesting question to determine the motion of this axis during the past two or three centuries, and Dr. Bauer's paper was an attempt to solve this problem as far as is possible with the data at present at command.

No. 12 was also read in brief abstract by the Secretary. It stated that as yet no formulæ had been found by which the diurnal range of the magnetic declination, for example, could be computed for various portions of the earth. The author has found the following simple formulæ to hold true within the fluctuations to which the quantities themselves are subject: Diurnal range of declination $= 2'.58 \sec^2 \varphi$; diurnal range of inclination $= 6'.1 \div 1 + 3 \sin^2 \varphi$; wherein φ, the magnetic latitude, is found from the equation $\tan \varphi = \frac{1}{2} \tan \mathrm{I}$, in which I is the magnetic dip. The first formula was discovered empirically, then under cer-

tain assumptions deduced theoretically. The second was then derived theoretically and was found to satisfy the data.

An abstract of No. 13 was read by the Secretary. It follows the theory of perturbations in the problems of mechanics in the order of its historical development from Lagrange to Lie with a view to the final presentation of the theory in its just position as one phase of Lie's theory of contact-transformations.

No. 14 was presented by the Secretary. It gave a bibliography of the Pythagorean proposition, followed by a general solution of the equation $x^2 + y^2 = z^2$, and concluded with an extensive numerical table of the sides of rational right-angled triangles.

No. 15 expressed in terms of the tabulated E and F functions a number of integrals, many of which had apparently never been completely worked out.

No. 16 showed how to express the effect of a small difference in the equatorial moments of inertia of the earth on the period of revolution of the instantaneous axis of rotation around the axis of figure. A remarkable value is obtained for the average angular velocity of that revolution, and a formula is deduced for the difference in the equatorial moments essential to explain the discrepancy between the observed and computed value of the Eulerian cycle.

No. 17 considered the case of no applied forces, or that in which there is conservation of moment of momentum. The problem is of practical interest in its application to the question of variation of latitudes on the earth. Several new theorems with respect to the motions of the mass were derived.

No. 18 obtained some general properties of a class of functions of which the spherical harmonics are special cases.

No. 19 described the present annoying state of the subject-matter of notation and coordinate systems, and advocated the adoption of certain standards. It is expected that this question will be further discussed at the Boston meeting with a view to obtaining a consensus on symbols and fundamental conventions.

No. 20 called attention to a certain quadrilateral whose properties throw new light on the theory of the Pascal lines of a hexagon inscribed in a conic.

In presenting No. 21 Professor Greenhill gave stereoscopic views of certain interesting curves in space and pointed out the bearing of some of them on certain parts of the theory of elliptic functions.

The section is also indebted to Professor Greenhill for interesting contributions to the discussions on many of the other papers.

The officers elected for the Boston meeting are Professors E. E. Barnard, of Yerkes Observatory, and Alexander Ziwet, of the University of Michigan.

JAMES MCMAHON.

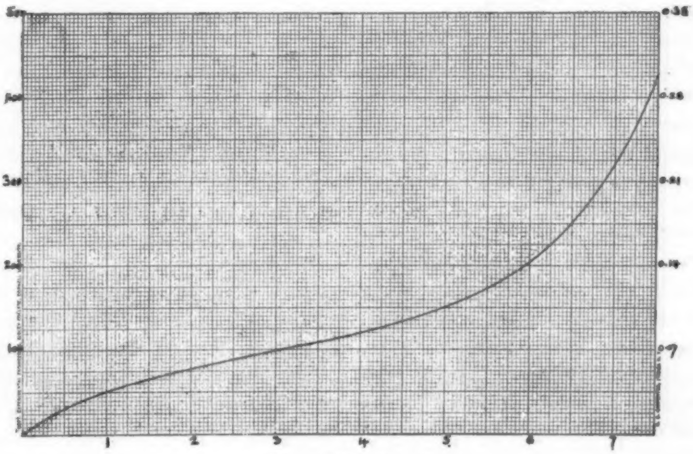
SINGULAR STRESS-STRAIN RELATIONS OF INDIA RUBBER.

THE curious and unaccountable behavior of India rubber in thermodynamic transformation of energy under load has long been familiar; it is, perhaps, even more generally known that it exhibits a peculiar relation of elongation to load when approaching its limit of tenacity, but I am not aware that this later phenomenon has ever been exhibited by formal test or by graphic representation of the results of such tests. It is a matter of common observation that, when this substance is subjected to a pull of steadily increasing intensity, its resistance increases as does that of any elastic and ductile material; but that, at the end, instead of suddenly losing power of resistance, or even snapping without observable decrease of load, its resistance for a time rapidly and largely increases up to the point

of rupture. This can be readily felt in even the breaking of one of the small bands of partially vulcanized rubber now so universally employed for filing papers and other purposes. At the end of the period of extension the resistance rises so rapidly as to produce the sensation of bringing the hand up against a rigid obstacle, resisting further elongation.

Figure 1 is the stress-strain diagram of a strip of rubber, partially vulcanized, but not sufficiently to disguise the peculiar characteristics of the material.

Studying this diagram, it will be observed that the substance behaves precisely like other familiar materials, up to a point which, in this case, is found at a load of thirty per cent. of the maximum, the breaking load, and at an extension one half the maximum. At this point there exists a reversal of the line, and the curvature is thence maintained convex to the axis of X, up to the point of rupture; fracture taking place, at the end, sharply and without any indication of that method of flow of the mass which, in the case of the irons and softer steels, for example, permits a falling-off of resistance after passing a point of maximum tenacity well within the breaking limit. The ratio of increase of load to increase of elongation steadily increases from the zero point, as with all substances, other than iron and steel, so far as known, up to this point of contrary flexure on the diagram; at which place the ratio is inverted and resistance increases in greater proportion than extension, finally assuming a comparatively high value.



Strain per Unit Length.

FIG. 1.—Stress-Strain Diagram of India Rubber.

The singularity of this action will be brought into relief by examining the diagrams produced with other materials employed in the arts.* Swedish or Norway Iron, Common Merchant Iron, 'Mild' Steel, and Tool-Steel have been subjected to loads increasing to the point of rupture, with occasional removal of the load.

*Thurston's Materials of Engineering, Vol. II., p. 611.

The nearly-vertical lines on each curve, at intervals, from the origin, are the 'elasticity lines,' as they have been called, showing the action of the material when the load is gradually relieved. These substances do not restore themselves to the original dimensions, but remain permanently distorted, taking more or less set and, usually at least, maintaining a constant value of the modulus of elascity. The slight droop in each line, near its outer extremity, shows the behavior of the substance when the load is left unchanged and elongation is maintained constant. This 'exaltation of the elastic limit' was discovered by me many years ago, and announced to the American Society of Civil Engineers in 1873.* India rubber exhibits none of the phenomena giving the characteristic form of the diagrams of the irons and steels. Even when stretched to the point of rupture it restores itself very nearly to its original dimensions and gradually recovers a part of the loss of form at that instant observable. Its almost complete stability of form when relieved from load, and especially when in the shape of springs such as are used on railway trucks, constitutes one of its most valuable properties. Like cork, when confined laterally, it is practically indestructible and incapable of distortion when used as a spring. The singular stress-strain relations of the substance may probably be found to give it peculiar value for many other purposes. The sample illustrated by our diagram was of the kind employed for springs and rubber bands and, as usual, slightly vulcanized.

The equation of the curve of this character described by the materials of construction generally may be taken, without important error, usually, as of the form

$$E=a\sqrt{T};$$

and with elongation, E, and T, tenacity, respectively, in per cent. of total length of specimen and in pounds per square-inch, the constant, a, is usually not far from 0.1 for good irons, 0.05 for tool-steels, and for good soft copper it is about 1.2. For this specimen of india rubber the equation is obviously so entirely different in class and form, and indicates so evidently an entirely different method of molecular action in resistance of strain, that it must constitute a problem by itself. The peculiarities of this form may, however, prove a key to the corresponding singularities of its internal structure and forces. So far as known, no other substance gives such unique relations of forces holding the substance in stable form to the variations of form to which the external application of force gives rise. The volume of the mass remains, so far as can be seen, constant, or nearly so, and the expenditure of work upon the substance results simply in changing the intermolecular distances of adjacent particles. This fact will probably be found to simplify the process of experimental interpretation of this curious case.

The cause of the singular behavior of this thermodynamically unique material remains to be discovered. It is probably safe to assume that its mechanical and physical properties will have some close relationship, and that the investigation, to be complete, must comprehend both lines of research. The gum must evidently possess either some very strange molecular force-relations or it must be the fact that, in the case of the ordinary materials of engineering and construction, these apparently peculiar characteristics are, in them, as yet unobserved because of their minute effects. The study of the subject cannot fail to lead to new and interesting facts relative to the molecular constitution of this and probably of other substances.

R. H. Thurston.

Cornell University.

* Trans. Am. Soc. C. E., November, 1873.

FIFTEENTH ANNUAL REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

THE Committee on Indexing Chemical Literature presents to the Chemical Section its fifteenth annual report, covering the twelve months ending August, 1897.

WORKS PUBLISHED.

Recalculation of the Atomic Weights. By FRANK WIGGLESWORTH CLARKE. New edition revised and enlarged. Constants of Nature, Part V. Smithsonian Miscellaneous Collections, 1075. City of Washington. 1897. Pp. vi+370. 8vo.

Index to the Literature of the Periodic Law. In: 'Development of the Periodic Law.' By F. P. VENABLE. Easton, Pa. 1896. 12mo.

Partial Bibliography of Argon. By C. LE ROY PARKER. Accompanying his paper: 'Our Present Knowledge of Argon.' J. Am. Chem. Soc. xix+124 (February, 1897).

Bibliography of Agricultural Chemistry (American). Bulletins of the Office of Experiment Stations, United States Department of Agriculture.

In our fourteenth annual report the following correction should be made: *for* Bulletin No. 9 *read* Bulletin No. 19, *and add* Bulletin No. 27 (1897).

A card-index to Experiment Station Literature is issued by the Office of Experiment Stations; this is sent *gratis* to all the agricultural colleges and experiment stations in the United States, and is sold to a limited number of individuals and institutions. Eleven thousand cards had been distributed prior to September, 1896.

The detailed index included in each volume of the 'Experiment Station Record' contains numerous references to chemical articles published by the experiment stations in the United States and in foreign countries.

Abstracts of Chemical Work in Agricultural Science, published in: 'Experiment Station Record,' issued by the Office of Experiment Stations, United States Department of Agriculture.

These abstracts were begun in Vol. I., No. 1. (September, 1889). Abstracts of foreign investigations were added, beginning with Vol. II., No. 8 (March, 1891), and these have been included, with a quite rapid growth in the field covered, up to the present time. The work is in charge of Dr. E. W. Allen, who is assisted by Mr. W. H. Beal in the department of fertilizers and soils, and by the Committee on Abstracting of the Association of Official Agricultural Chemists.

The Review of American Chemical Research, edited by Professor Arthur A. Noyes, begun in April, 1895, and formerly published in the 'Technology Quarterly,' is continued in the 'Journal of the American Chemical Society.'

Periodicals Relating to Chemistry and Physics in the New York Public Library and Columbia University Library. Bulletin of the New York Public Library, Astor, Lenox and Tilden Foundations. Vol. I. No. 6. June, 1897. Page 152.

A very convenient check-list compiled with bibliographical accuracy, especially useful to students residing in New York and vicinity.

Bibliography of the Analysis of Chrome-iron Ore, Ferro-Chromium and Chrome-steel. By S. RIDEAL and S. ROSENBLUM. *Chem. News,* Vol. 73, p. 2. (January 3, 1897.)

A Bibliography of the Chemistry of Chlorophyll, by L. Marchlewski, accompanies his monograph: 'Die Chemie des Chlorophylls.' Hamburg and Leipzig. 1895. 8vo.

REPORTS OF PROGRESS.

A Bibliography of the Metals of the Platinum Group, 1748–1896, by Professor James Lewis Howe, has been completed, and after examination by your Committee has been recommended to the Smithsonian Institution for publication. The work is now going through the press.

A Review and Bibliography of Metallic Carbides, by Mr. J. A. Mathews, of Columbia University, was submitted to your Committee, and after examination by each member the MS. was returned to the author for minor improvements. The suggestions of the Committee were promptly accepted by Mr. Mathews, and the revised work has been recommended to the Smithsonian Institution for publication.

A Bibliography of Basic Slags, Technical, Analytical and Agricultural, has been completed by Karl T. McElroy, of the Division of Chemistry, U. S. Department of Agriculture. The channel of publication has not been determined.

*Presented at the Detroit meeting of the American Association for the Advancement of Science.

The second edition of the *Catalogue of Scientific and Technical Periodicals*, 1665–1895, by Dr. H. Carrington Bolton, is entirely printed, but publication is deferred, owing to the preparation of a new Library Check List, with which it will be accompanied. The new edition contains 8,603 titles.

CHEMISTRY.

A Supplement to the Select Bibliography of Chemistry, 1492–1896, has been completed by Dr. H. Carrington Bolton, who has presented the MS. to the Smithsonian Institution. This Supplement contains about 9,000 titles, including many chemical dissertations, and is brought down to the end of the year 1896.

Dr. C. H. Jouet reports his *Index to the Literature of Thorium* 'nearly finished.'

Dr. F. W. Traphagen reports 'fair progress' on his *Index to the Literature of Tantalum*.

Mr. George Wagner reports that he has made progress on the *Bibliography of Oxygen*.

Mr. H. E. Brown, under the direction of Professor A. B. Prescott, is preparing a *Bibliography of the Constitution of Morphine and related Alkaloids*.

Professor William Ripley Nichols, of the Massachusetts Institute of Technology, at the time of his death left an unfinished *Index to the Literature of Carbonic Oxid*; the manuscript was taken in hand by Professor Augustus A. Gill, of the same institution, who has done considerable work upon it; he now reports that he is not in a position to finish the task and he is perfectly willing to relinquish the large amount of material accumulated to anyone who would undertake to complete it.

Professor Clement W. Andrews, formerly of the Massachusetts Institute of Technology and now Librarian of the John Crerar Library, Chicago, reports that he is obliged to abandon work on his *Index to the Literature of Milk*, and will be very glad to turn over the material to anyone who cares to undertake to complete the bibliography.

It has always been the aim of the Committee on Indexing Chemical Literature to prevent duplication of work, but failure to inform the Committee of work in progress may defeat this undertaking. An announcement, in the Fourteenth Annual Report, of certain work having been nearly completed surprised a chemist in another part of the country, and has led to the abandonment by the latter of much laborious indexing.

In conclusion the Committee repeats the statement that it labors to encourage individual enterprise in chemical bibliography, and to record in the annual reports works issued and works in progress.

Address correspondence to the Chairman, at Cosmos Club, Washington, D. C.

H. CARRINGTON BOLTON, *Chairman*,
F. W. CLARKE,
A. R. LEEDS,
A. B. PRESCOTT,
ALFRED TUCKERMAN,
H. W. WILEY,
Committee.

CURRENT NOTES ON ANTHROPOLOGY.

THE STONE AGE OF PHŒNICIA.

THE associations of Phœnicia with both sacred and profane history are so numerous that a careful investigation of its oldest human remains will attract general attention. Such an investigation is reported in *L'Anthropologie*, Nos. 3 and 4 of this year, by Professor Zumoffen, of Beyrut, Syria.

He gives a map of the prehistoric stations, and divides them into 'paleolithic' and 'neolithic,' according to the French canons of archæology. Of the former he describes six which he has explored. Two full-page plates present the objects in natural size. The most important finds were in a cavern in the valley of Antelias, which has also been visited by previous students (Fraas, Dawson).

Examined by the canons of American archæology, the claim for the vast antiquity of these remains is open to some doubts. Patination, which the author emphasizes, is dependent on soil and dampness more than age; one or more of the six stations he acknowledges were workshops, and the remains, therefore, are to be classed as 'rejects.' This explains the absence of pottery; but most significant is the fact (p. 426) that the fauna of the 'paleolithic'

and the 'neolithic' stations were the same, while the stratigraphic relations of the deposits are inconclusive.

ARCHÆOLOGICAL SURVEY OF OHIO.

IN a neat pamphlet of 110 pages, reprinted from Vol. V. of the Ohio State Archæological and Historical Society, Mr. Warren K. Moorehead, Curator of the Society, gives a readable report of the field-work carried on in the Muskingum, Scioto and Ohio valleys during the year 1896. The exhibit is most creditable to his energy and judgment. The aim of his investigation is to produce a reliable archæological map of the State, and also to examine critically some of the most remarkable ancient monuments and to collect the art remains of the former inhabitants. In all these directions he has been quite successful. Nearly seven thousand monuments of the indigenous tribes have been located and mapped. A limited number have been carefully excavated, and the total number of specimens obtained runs up into the tens of thousands.

The report is illustrated with forty-five figures in the text of noteworthy mounds or valuable specimens, and much collateral information relating to them is inserted. One prominent advantage has been the educational influence of the survey on the population. It is gratifying to learn (p. 261) that there are now in Ohio 310 persons interested in its archæology! Can any other State equal this record?

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

NOTES ON INORGANIC CHEMISTRY.

PROFESSOR MOISSAN and Professor Dewar publish in the *Comptes Rendus* further experiments on liquid fluorin. The boiling point is $-187°$; at $-210°$ it still remains liquid, showing no sign of solidification. The density was determined by suspending in it several different substances which are unacted upon; amber was found to rise and fall in the liquid, hence its specific gravity was 1.14. No absorption bands were found by the spectroscope, and between the poles of a powerful electromagnet it showed no magnetic phenomena. Its capillarity is less than that of liquid oxygen and only one-sixth of that of water. At $-210°$ it has no action on dry oxygen, water or mercury, but at this low temperature it still reacts violently with hydrogen, and even with the hydrogen in oil of turpentine. The explosive substance which in previous experiments they obtained when fluorin was led into liquid oxygen is not formed if oxygen is perfectly dry, and appears to be a hydrate of fluorin.

IN the *Pharmaceutische Zeitung* F. Sibbers, writing on the analysis of aluminum, claims that the proportion of silicon present is always underestimated, from the fact that when aluminum is dissolved in acid a conconsiderable part of the silicon is evolved as hydrogen silicid and lost. The average amount of silicon usually found in aluminum is 0.3 %, but taking into consideration that which is lost in analysis the author considers that 0.6 % is usually present. As the presence of silicon is considered to be very detrimental to aluminum, these determinations of Sibbers deserve careful consideration.

DR. H. CARRINGTON BOLTON, whose Bibliographies of Chemistry and Scientific Periodicals have proved of so much value to chemists and other scientists, as well as to librarians, and who has done so much to throw light upon obscure points in the history of chemistry, has again put American chemists under obligation to him by a paper on 'Early American Chemical Societies,' which was recently read before the Washington Chemical Society, and now is reprinted from the *Journal* of the American Chemical Society. It appears that before

the end of the first quarter of the present century three chemical societies had been founded in this country, while the first chemical society of Europe, the Chemical Society of London, was not founded till 1841. Forty-nine years before this date, in 1792, the Chemical Society of Philadelphia was instituted. Its first President was Dr. James Hutchinson, and at his death he was succeeded by Dr. James Woodhouse, who was at that time professor of chemistry in the medical department of the University of Pennsylvania. Among the best-known members were Dr. Joseph Priestley and Robert Hare, the inventor of the oxy-hydrogen blowpipe. "The meeting of October 24, 1801, was made memorable by the appointment of a committee for the 'discovery of means by which a greater concentration of heat might be obtained for chemical purposes.'" On this committee was Robert Hare, then only twenty years old, and December 10th of the same year he reported, on behalf of the committee, his great invention. No memoirs were published by this Society, and how much longer it existed is a matter of conjecture. In August, 1811, the Columbian Chemical Society was founded, also at Philadelphia. It numbered sixty-nine 'Honorary' (regular) members, of whom thirty-one were Europeans, and thirteen 'Junior' (associate) members. Thomas Jefferson was patron; James Cutbush, President, and among the more distinguished members were Benjamin Smith Barton, Archibald Bruce, Joseph Cloud, Thomas Cooper, Robert Hare, James Madison, Benjamin Rush, Adam Seybert and Benjamin Silliman. The foreign members included the most distinguished chemists of England and France, and Proust of Madrid. No Germans were on the list, nor Berzelius. One volume of memoirs was published in 1813, now a very rare book. In his article Dr. Bolton gives interesting abstracts of the papers in this volume. September 6, 1821, there was founded at Delhi, New York, the Delaware Chemical and Geological Society, a local society of forty or fifty members, having 'for its object the improvement of the members in literature and science, especially in chemistry and mineralogy.' Considering "the limited facilities for acquiring chemical knowledge in the New World" (chiefly in the medical schools) "and the distance of amateurs from the European head-centers of learning, it is certainly noteworthy that American chemists combined to form associations for mutual improvement and the advancement of their calling at so early a period." The fourth chemical society in this country was the American Chemical Society, founded at New York in 1876, and broadened in its scope in 1892, until it now numbers 1,106 members, working in nine chartered sections, representing forty-seven States and Territories, and several countries of Europe, South America, and even Australia.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

We record, with deep regret, the death at Philadelphia, on November 14th, of Dr. Harrison Allen, emeritus professor of comparative anatomy in the University of Pennsylvania.

The American Psychological Association will meet at Ithaca, in conjunction with 'The Naturalists' and affiliated societies, on Tuesday, December 29th, and the two following days, under the presidency of Professor J. Mark Baldwin, of Princeton University. It is intended to place papers on experimental and physiological psychology on the first day and on the final day papers having closer relations with philosophy. On Wednesday morning there will be a discussion on 'The Psychology of Invention,' which it is expected will be opened by Professor Josiah Royce, Harvard University; Professor John Dewey, University of Chicago, and Professor Joseph Jastrow, University of Wisconsin.

A committee of the American Chemical So-

ciety appointed in 1893 issued a circular letter addressed to foreign chemical societies, with a view to organizing a series of international chemical congresses, similar to the International Congress of Chemists held in connection with the World's Columbian Exposition. This committee has been compelled to report through its chairman, Professor F. W. Clarke, that a few favorable replies were received from minor organizations, but not from any of the great chemical societies, and the committee asks to be discharged, leaving the initiative to other organizations.

DR. B. ENGELHART has given up his observatory at Dresden and presented the instruments and library to the University Observatory at Kasan.

DR. MARK OLIVET, professor of psychiatry in the University of Geneva, and the author of numerous publications on medicine and hygiene, died at Geneva on October 24th, in his seventy-sixth year.

A MONUMENT to Duchenne has been erected in the Saltpêtrière. Duchenne began at Bologne by treating nervous diseases with electricity, and after he went to Paris never held any university or hospital position, but to him we owe the first description of locomotor ataxy and many forms of muscular wasting, as well as important advances in the physiology of movement.

PROFESSOR VON KÖLLICKER, Würzburg, has been given the Anders Retzius medal by the Association of Swedish Physicians.

PROFESSOR VON RÖNTGEN, Würzburg, has been elected an honorary member of the Swiss Scientific Society, Berne.

IT is stated in *Nature* that Professor F. Omori, of the Seismological Institute, Tokio, is now in India, for the purpose of investigating the recent Calcutta earthquake and reporting on the same to the Japanese government.

DR. LEHMAN NIETSCHE has been appointed keeper of the anthropological department of the La Plata Museum, succeeding Dr. Ten Kate.

THE Appalachian Mountain Club of Boston gave a reception on Monday of this week, at which were exhibited Harvard Geographical Relief Models, new Sella Photographs and photographs of the mountains along the Great Northern Railway. On November 10th Professor William M. Davis addressed the Club on the Harvard Geographical Models.

DR. KAKICHI MITSUKURI, the eminent zoologist, professor in the University of Tokio and delegate from Japan to the recent conference on seal fisheries, lectured this week at Johns Hopkins University, of which he is a former student.

THE following courses of lectures on natural science are being given at the Philadelphia Academy of Natural Sciences under the Ludwick foundation. They are given at 4:30 in the afternoon and admission is free. The subjects are: 'Malacology,' Professor Henry A. Pilsbry, November 1st, 8th, 15th, 22d, 29th, December 6th; 'Geology,' Professor Angelo Heilprin, November 2d, 9th, 16th, 23d, 30th, December 7th; 'Invertebrate Zoology,' Dr. Benjamin Sharp, November 3d, 10th, 17th, 24th, December 1st, 8th; 'Vertebrate Zoology,' Witmer Stone, M.A., November 5th, 12th, 19th, 26th, December 3d, 10th; 'Hygiene and Sanitation,' Dr. Seneca Egbert, January 7th, 14th, 21st, 28th, February 4th, 11th; 'Botany,' Mr. Stewardson Brown, January 10th, 17th, 24th, 31st, February 7th, 14th; 'Entomology,' Professor Henry Skinner, January 12th, 19th, 26th, February 2d, 9th, 16th.

AT the meeting of the Botanical Club of the University of Chicago, on November 9th, the hour was devoted to a brief review of the life of the late Professor Julius von Sachs. Professor Coulter read a translation of a short history of Sachs' life prepared by his pupil, Dr. Fritz Noll, which will appear in the *Botanical Gazette*. Professor Loeb then gave some personal reminiscences of von Sachs.

COMPLETE plans for the Zoological Gardens in Bronx Park have been prepared by Heins & La Farge, the architects, and were laid before the Park Commissioners on Monday. There has not been much change from the present topography of the Park, which the architects and experts found admirably adapted for the purposes of the Zoological Gardens.

AT the last meeting of the Trustees of the New York Public Library, Mr. Andrew A. Green offered a resolution for the appointment of a com-

mittee to consider and report on the expediency of uniting all the public libraries in the city. Mr. Green, Mr. Lewis C. Ledyard and General Philip Schuyler were appointed members of the committee. The intention of this resolution is to put all the public libraries under one working head and management and systematize the work throughout the city, the New York Free Circulating Library being the library that the the Trustees especially desire to have united with the New York Public Library.

THE corner stone of the new building for the Bellevue Medical College, replacing that destroyed by fire and necessary owing to the failure of the plan for consolidation with New York University, was laid on the afternoon of November 13th. Mr. D. Ogden Mills, President of the Board of Trustees, made an address, and addresses were made in the Carnegie Laboratory by the Rev. Roderick Terry, of the Board of Trustees; Dr. Langdon Gray, representing the Alumni, and Dr. John S. Billings, for the medical profession. The new building, which occupies a plot of ground 75 x 100 feet, will be of granite and brick, five stories in height, and is expected to be ready in the spring.

AT the inaugural meeting of the Röntgen Society, to which we referred last week, after the address by Professor Silvanus P. Thompson, there was an exhibition of apparatus and photographs. In its account the *Times* mentions only two exhibits, both from America: "In the hall a splendid assortment of photographs was exhibited, perhaps the most striking being a life-sized skiagram of the entire skeleton of a full-grown living woman, taken by Dr. W. J. Morton, of New York. Apparatus for the production of Röntgen rays was also on view, the chief novelty being an electric oscillator, made and specially sent by Mr. Tesla, in the construction of which no thin wire is employed. When one of Tesla's own tubes is excited with this machine the emission of Röntgen rays is so intense that, standing 50 feet away from it, one can still obtain on a luminescent screen the shadow of the bones of one's hands."

WE learn from the *Botanical Gazette* that Dr. J. M. Rose returned from his Mexican trip early in October. His work was chiefly confined in the little-known parts of the Sierra Madre. He visited Guaymas, La Paz (L. C.), Mazatlan and Acaporeta, on the western side, crossed the two ranges of the Sierra Madre north of the Acaporeta and made two excursions into them, one from the west at Rosario, and the other from the east at Bolanos, the latter being one of Seeman's stations. The States chiefly explored were Durango, Jalisco, Zacatecas and the Territory of Tepic. The collection contained 2,000 numbers, and is especially rich in umbellifers, agaves and orchids, many living specimens of the two latter groups having been shipped for cultivation.

MR. A. P. MORSE, curator of the zoological museum of Wellesley College, has returned from a collecting expedition to the Pacific coast, planned under the direction of Mr. S. H. Scudder. He has brought back large collections, especially of orthoptera, for class work and for the museum.

A CABLEGRAM from Stockholm states that King Oscar and a number of private persons have contributed sufficient sums of money to insure the despatch of a Swedish Polar expedition in 1898, which will be led by Professor Nathorst, the geologist. The cost of the expedition is estimated at 70,000 crowns.

THE seals caught at sea during the present season are said to be fewer than last year. The figures reported are as follows: Total catch of seals in the north Pacific for the present season, 38,700 against 73,000 last year. The catch in Bering Sea, which is that portion of the north Pacific in which the United States is interested, is 16,650 for the present season, against 29,500 last season, a reduction of about one-half. Of the catch in Bering Sea, British vessels took 15,600, American vessels 1,050.

MR. H. C. MERCER and Professor H. C. Warren have retired from the board of associate editors of the *American Naturalist*. We understand that hereafter anthropology and psychology will not be included in the scope of the journal.

THE *Asa Gray Bulletin*, eidted by Mr. J. H. Hicks, is now being published at Washington as a bi-monthly magazine for popular botany.

BEGINNING with next year, a journal, enti-

tled *Archives de Parasitologie*, edited by Professor Raphael Blanchard, will be published at Paris.

THE current number of Virchow's *Archiv* is the 150th and is published fifty years after the establishment of the *Archiv*, in 1847. It contains a portrait of Virchow and two articles added to the long series contributed by him since he published seven in the first volume, fifty years ago.

THE *Open Court* for the present month has as a frontispiece a portrait of Euler and publishes some biographical notes on the great mathematician. Portraits of other mathematicians will be given in other numbers of the journal.

MESSRS. HOUGHTON, MIFFLIN & Co. have published for the Appalachian Mountain Club, of Boston, a guide book to the region about the city, prepared by Mr. Edwin M. Bacon. It contains 410 pages, with four folding maps and 150 illustrations. The opening chapter quotes President Eliot's characterization of the country round about Boston as the most interesting historical region in the United States, and one of the most beautiful he had ever seen here or in Europe; and his advice to the students is 'to learn the whole region by heart.' For this purpose the book, which pays special attention to the natural history of the region, will be a most useful guide.

IN a recent paper, published in the Transactions of the Edinburgh Field Naturalists' and Microscopical Society, Mr. Symington Grieve brings the history of the Great Auk down to July 31st of this year, noting the new specimens of eggs which have come to light within the past few years as well as the changes that have taken place in the ownership of specimens. It appears that the highest price paid for an egg was 300 guineas by Sir Vauncey H. Crewe, while Mr. Rowland Ward gave 600 guineas for a skin and egg. The article is accompanied by five plates of mounted specimens, three of which are of special interest from the fact that they are from young individuals.

ACCORDING to the *Botanical Gazette* the two important collections left by the late Dr. Edmund Russow, of the University of Dorpat, are to be sold. One is a collection of about 3,750 fully prepared and well preserved microscopical preparations, including the original mounts used for the late owner's classical investigations. The second collection is the Sphagnum collection, of which group Russow was known as one of the foremost students. It consists of 314 fascicles and about 3,000–4,000 microscopical preparations, with outline sketches of the same, especially of the species that have been already worked up. There are, in addition, 300 photographic lantern slides of localities of the different sphagnums. Further information regarding the collections may be obtained from Frau Professor Emma Russow, Schloss Str., 15, Dorpat, Russia.

REUTER'S agency reports that at the headquarters of the Russian Imperial Geographical Society, on the 27th inst., M. Sven Hedin, the celebrated Swedish traveler, delivered an address before a large and brilliant audience upon his recent journey across the Pamirs, Kashgaria and the Lob Nor. He started at the beginning of 1894 for the Pamir military post in Kashgaria, and ascended and mapped the glaciers of Mustagh Ata (20,000 feet). During the autumn he proceeded in the direction of Lake Teschil-Kul to explore it, and also the Alid-Schur Mountain range. He returned to Kashgar to pass the winter, and spent the time in arranging the scientific material which he had collected. In February, 1895, M. Sven Hedin set out to cross the Takla Makhan desert, but was compelled to return to Kashgar. In December, 1895, he went by way of Khotan towards Lake Lob Nor, traversing a desert 300 km. wide. During this journey which occupied four months and a half, M. Sven Hedin discovered the remains of two ancient towns and the ruins of Buddhist monuments. Proceeding as far as the Kiria Daria river he ascertained that this stream ran as far as 39° 30′ N. He found in that region a tribe of half-savage shepherds, unknown even to the Chinese. Pushing on to the Chinese town of Koreia, along the banks of the river Tarim, M. Sven Hedin reached the Chinese, or northern, part of Lake Lob Nor. From LobNor, in the spring of 1896, he came back to Kholan, and then returned to Kipa, in order to undertake a journey in north-

ern Tibet and on the heights in that region. During this expedition the explorer discovered a lofty mountain range, whose highest peak rose about 24,000 feet above sea level. This was named Mount Oscar. He also found in this region twenty-three salt-water lakes. M. Sven Hedin then proceeded *via* Tsaidam, Kuku Nor, Si-ning-fu, Liang-chu, the deserts of Alashan and Ordos to Peking, which city he reached on March 14, 1897, across northern China. The expedition, the cost of which was defrayed by the King of Sweden, M. Nobel and several other rich Swedish gentlemen, was the means of securing botanical, geological and archæological collections, notably several ancient Buddhist MSS., found at Khotan, and about 500 sheets of topographical plans, as well as a large number of photographs.

THE lecture at the annual public meeting of the five Paris Academies was given by M. Moissan, who chose as his subject 'The University of Chicago,' and made use of impressions obtained on his recent visit to America. The address, published in the last number of the *Revue Scientifique*, may be read with profit and amusement. After an introductory paragraph M. Moissan begins: "Il y avait une fois, à l'Université de Yale, près New-Haven, un professeur de langues hébraïques nommé Harper. Cet homme, qui avait beaucoup voyagé et qui connaissait bien les établissements d'instruction de son pays, avait la prétention de fonder la plus grande université des Etats-Unis. Sans cesse il poursuivait cette pensée, s'enfermant en elle et lui donnant le meilleur de son intelligence. Son idée devint une idée fixe, et ce qu'il y avait de plus grave, c'est qu'il raisonnait parfaitement son cas. Il prétendait, ce professeur d'hébreu, qu'une université vraiment digne de ce nom devait présenter certaines qualités particulières. Il voulait, par exemple, la séparation complète de l'enseignement supérieur et de l'enseignement secondaire, ce qui ne se fait pas souvent aux Etats-Unis."

THIS year's experience with yellow fever in the South, which has cost the country more than sixty million dollars, says the Boston *Transcript*, has led to a movement among medical and scientific men to have the disease studied more thoroughly than heretofore and, if it is possible, to control it as they have other infectious and contagious diseases. A committee of seven, which was appointed by the American Public Health Association at the annual meeting in Philadelphia a short time ago, has waited upon President McKinley and laid before him the urgent necessity, as viewed by the Association, for the appointment by Congress of a commission of expert bacteriologists to be sent to Havana for the purpose of making a thorough study of the cause and prevention of yellow fever. This committee consists of Dr. H. B. Horlbeck, Charleston, S. C.; Dr. Samuel H. Durgin, of Boston; Dr. A. H. Doty, of New York; Dr. G. M. Sternberg, U. S. A.; Josiah Hartzwell, Canton, O:; Dr. S. R. Olliphant, New Orleans, La., and Dr. R. M. Swearingen, Austin, Tex.

THE last number of the *Journal of Comparative Neurology* contains the text of four 'Lectures on the Sympathetic Nervous System,' given before the medical students of the University of Michigan in May, 1897, by Dr. G. C. Huber. The newer literature is critically reviewed in the light of the author's own researches, which are also quite fully outlined, and especial attention is devoted to the problem of the relation of the neurons in the sympathetic system. The original figures illustrate the sympathetic endings on striated and non-striated muscle cells, cardiac muscular cells, blood vessels, gland cells, epithelium of the bladder and the cells and pericellular baskets of the sympathetic ganglia of various vertebrates, together with diagrams in colors of the course and distribution of several systems of sympathetic neurous.

THE report of the Engineer-in-Chief of the United States Navy, just issued, includes the statement of the year's work in testing materials for machinery by Chief Engineer E. R. Freeman, who has had charge since the late change of policy, which permitted the assignment of work to engineer officers which had previously often been largely performed by inexpert officers of other departments. The supervising inspector reports that the present system of conducting the inspection of steel has thus

far proved very satisfactory, and has a very decided advantage over the former system in the point of time required to establish understandings between the manufacturers and the Bureau. There are many questions arising in the inspection of steel which can be decided or answered only by reference to the Bureau's plans and specifications, and which now come direct to the Bureau; whereas under the former system of inspection they came through the Steel Inspection Board, and the information desired in connection with them was, of course, returned to that Board for its decision, thus causing much delay. The inspection of steel and the designing of machinery made of that material being now under one head, the plans and specifications for that machinery and the specifications for that steel can be better adapted to the full capabilities of the steel maker, and will not be apt to ask of him anything beyond his capabilites.

THE visitation of Algeria by locusts last year is described in the last report of the British Consul-General, which is quoted in the London *Times*. It seems that Algeria was visited twice during the year, the first flight appearing in the winter as far north as the Mediterranean coast, and a second one, which was normal, in the spring and early summer. There is no record of any flight such as the early one in the history of Algeria, and as they appeared so early it was believed they were sterile; but the females began to lay in the usual way, only several months too soon. But in place of being hatched out in the usual period, they took more than twice as long, which seems to be something wholly new and unexpected in the life history of locusts. The appearance of the insect so far north as the Mediterranean in mid-winter is believed to be due to the drought which in the previous year devastated the southern districts and the Morocco Sahara. There being no vegetation in the Sahara, the locusts were forced to leave the grounds where they spend the winter, and, without making the usual halts, to hurry forward to places where food was obtainable. Up to this it was believed that the *maximum* period for the incubation of the eggs was 45 days; but it has been shown now that it extends in some cases to 70 days, so that the period may vary, according to the time of the year, from 15 days to 70. This unexpected visitation was met by exceptional exertions on the part of the government, the local authorities and trade committees. Oran, the province adjoining Morocco, was the only one invaded. The area over which the eggs were laid is estimated at 424,500 acres, and 270,120 bushels of young locusts were destroyed. The barriers, or lines of defence, made of the Cyprus apparatus, or of zinc, extended over 322 miles, while 27,113 ditches were dug at the foot of these to catch the young locusts. These figures do not take into account the work done by the administration of forests. The number of days' work furnished by natives during the campaign was 90,033. The efforts of the defenders were devoted mainly to saving the crops which were most valuable, such as the vines, and are said to have been very successful.

THE London County Council has adopted the following resolution: "That it be referred to the Parks Committee and to the Technical Education Board to consider and report as to the practicability of laying out plots of ground in certain parks in such manner as will afford assistance to scholars of elementary and secondary schools in the study of practical botany."

UNIVERSITY AND EDUCATIONAL NEWS.

THE report of the Treasurer of Yale University states that the additions to the funds of the institution during the past year amounted to $450,055, largely from the Fayerweather legacy. During the past ten years the funds of the University have been about doubled.

THIRTY scholarships have been established in the department of philosophy in the University of Pennsylvania, ten of which will be available this year, twenty next, and the whole number the following year.

PLANS have been adopted for the new Wilder physical laboratory at Dartmouth College. The building will be of brick, three stories high, 107 feet long by 56 deep, with a wing in the rear. It will front on College street, between the Richardson Hall and the Medical College. The building will provide lecture rooms and

laboratories for chemistry, physics and astronomy.

A MOVEMENT has been started at Raleigh, N. C., for the establishment by the State of a textile school. A committee has been appointed to correspond with all mill-owners, newspapers and Legislators. In the Georgia Legislature a bill is pending for the appropriation of $10,000 for the establishment of a textile school.

ON the recommendation of the governing board of the Sheffield Scientific School of Yale University, it has been decided to establish the degree of Master of Science, to be conferred on graduates of two years' standing or upwards, who have taken a first degree in science and who pursue successfully a higher course of study in science under the direction of the governing board.

DR LAFAYETTE B. MENDEL has been promoted to an assistant professorship of physiological chemistry in Yale University.

DR. GEORGE T. KEMP has been appointed professor of physiology in the University of Illinois.

THE director o Sibley College, Cornell University, has been authorized to establish a full professorship of railway machine design and locomotive construction. At present this work is carried on in existing departments.

PROFESSOR OSCAR LOEW, who has been for four years professor of agricultural chemistry in the University of Tokio, has returned to Munich. He will be succeeded by Dr. Bieler, now assistant in the laboratory of agricultural chemistry at Halle.

A CROOM ROBERTSON fellowship with an endowment of £8,000 has been created in the University of Aberdeen, with which Robertson was connected before being called to the Grote chair of philosophy of mind and logic in University College, London.

A CHAIR of geography has been established in the University of Würzburg.

THE Technical Institute in Munich has been given by the government 175,000 Marks for enlarging the electro-technical laboratory, 150,000 Marks for the erection of a laboratory for the agricultural station and 170,000 Marks for enlarging other buildings.

THE newly established medical school for women in St. Petersburg opens with 165 students.

THE Russian government has appropriated 400,000 roubles for the construction of a chemical laboratory at the Polytechnic Institute at Riga.

DISCUSSION AND CORRESPONDENCE.

DETERMINATE VARIATION AND ORGANIC SELECTION.

A FEW remarks may be allowed on the subject discussed in the reports of the papers of Professors Osborn and Poulton, on 'Organic Selection' in the issue of October 15th. I venture to make these comments now, although the more extended publication of the articles of the authors may remove my *causas scribendi.* Yet such preliminary reports have their main utility, to my mind, in arousing comments which may be of service to the authors.

I may throw my remarks into heads for the sake of clearness.

1. Professor Osborn's use of the phrase 'determinate variation' I find ambiguous, and the ambiguity is the more serious since it seems to me to prejudice the main contention involved in the advocacy of 'Organic Selection.' The ambiguity is this: He seems to use *determinate variation* as synonymous with *determinate evolution.* (See his discussion, SCIENCE, Oct. 15, pp. 583-4, especially p. 584, column 1, and paragraph 2 of column 2.) He says that *determinate variation* is generally accepted, and attributes that view to Professor Lloyd Morgan and myself. But it is only *determinate evolution* that I, for my part, am able to subscribe to; and I think the same is true of Professor Morgan.

'Determinate evolution' means a consistent and uniform direction of progress in evolution, *however that progress may be secured, and whatever the causes and processes at work.* Admitting 'determinate evolution,' the question, therefore, as to the causes which 'determine' the evolution is still open, and various answers have been given to it. The Neo-Lamarckians say

'use-inheritance' (as Eimer, who calls the determination secured by this means *Orthogenesis*); Weismann says, 'germinal selection; I have suggested 'Organic Selection' (the resulting determination of evolution being called by me 'Orthoplasy'); others say, 'determinate variation' (continued in the same direction for successive generations); Professor Osborn says, 'determinate variation' with 'organic selection.' *Determinate variation*, then, in the proper meaning of that term, is only *one way of accounting for determinate evolution;* and to my mind, it is not the true way; at any rate it is not at all involved in the theory of 'organic selection' as I have advocated it.

Let us look more closely at 'determinate variation.' Supposing that by variation we mean 'congenital variation,' then we may ask: When are variations determinate? When for any reason they are distributed about a mean different from that required by the law of probability or chance. The problem of determinate variations is purely one of *distribution*; and is to be investigated for each generation, quite apart from its holding for a number of successive generations (and so giving 'determinate evolution').

Further, the possible determinateness of variation is to be distinguished carefully from the *extent* or *width* of variation. By 'extent' of variation is meant the limits of distribution of cases about their own mean; while relative determinateness means the distribution of cases about a mean established in the earlier generation. The question of determinate variation is: *Has any influence worked to make the mean of variation of the new generation different from that which should be expected from the characters of their parents,* * *whatever the extent of variation.*

* I expressly avoid saying what this mean is, *i. e.*, what the contribution of each parent is to the average individual of their offspring; but the work of Galton goes far to establish it. Much more investigation is needed on this point of making out what is indeterminate variation; how insecure, therefore, the claim that variations are determinate! The drift of recent statistical studies goes, however (as far as I am familiar with them), directly to show that in their distribution—considered apart from their extent— variations follow the probability curve.

2. As I have said in a recent article * the assumption of the paleontologists (Osborn, *loc. cit.*, pp. 584–5) that because certain fossils show determinate progress—*determinate evolution*, therefore there must have been *determinate variation*, seems to me defective logic. It is one possibility among others, certainly, but only one. And as I held in the same article, instead of being necessary as a support for organic selection, the latter comes as a new resource to diminish the probability that the variations have really been determinate in these cases. They may be cases of orthoplasy involving organic selection working as an aid to natural selection upon 'coincident' variations which are yet not determinate but fortuitous in the strict sense.

3. Without going into the question, I may yet point out that the position taken by Professer Poulton in the matter of the relation of natural to organic selection is, as he says, that advocated by me (with some of the same arguments); but it may be recalled that I gave natural selection still further emphasis by making the 'functional selection from overproduced movements,' whereby motor accommodations are secured, itself a case of natural selection broadly understood. I have recently drawn up a table showing the various sorts of 'selection' under the distinction of 'means' and (immediate) 'result,' finding some twelve sorts of selection. I venture to reprint this table here, with the remarks which accompany it in my book on 'Social and Ethical Interpretations in Mental Development' (Macmillan, 1897), hoping that it may be discussed. The terms in the table which relate to social evolution are fully explained in the book; they are not so essential to the topic now before us.

The table and the remarks upon it (*loc. cit.*, Appendix B), slightly revised, are as follows:

"The various sorts of 'Selection' which it seems well to distinguish in different connections may be thrown together in the following table, the corresponding sections of the book (as far as there are such sections) being in each case given in brackets in the table beside the description:

* *The Psychological Review*, July, 1897, p. 397.

SELECTION.*

SORT.	MEANS.	RESULT.
1, 2. Natural Selection { I. Darwin, Wallace, Spencer) [40]. II. (Eimer) [40].	1. Struggle for Existence (Darwin, Wallace). 2. Inherent Weakness, without Struggle.	1. 'Survival of the Fittest' Individuals (Spencer). 2. Destruction of Unfit Individuals.
3. Germinal Selection (Weismann).	3. Struggle of Germinal Elements.	3. Survival of Fittest Germinal Elements.
4. Intra-Selection (Roux, Weismann, Delage).	4. Struggle of Parts (Roux).	4. Survival of Fittest Organs.
5. Functional Selection (Baldwin).	5. Overproduction of Movements (Bain, Spencer, Baldwin).	5. Survival of Fittest Functions.
6. Organic Selection (Baldwin, Osborn, Lloyd Morgan) [Appendix A].	6. Accommodation (Baldwin); Individual Adaptation (Osborn); Modification (Lloyd Morgan).	6. Survival of Accommodating Individuals.
7. Artificial Selection (Darwin).	7. Choice for Planting and for Mating together.	7. Reproduction of Desirable Individuals.
8. Personal Selection† [40].	8. Choice.	8. Employment and Survival of Socially Available Individuals.
9. Sexual Selection (Darwin) [40].	9. Conscious Selection by Courting, etc.	9. Reproduction of Attractive Individuals.
10. Social Selection† [40, 120].	10. Social Competition of Individuals and Groups with Natural Selection (Malthus, Darwin).	10. Survival of Socially Fittest Individuals and Groups.
11. Social Suppression† [38 ff].	11. Suppression of Socially Unfittest (by Law, Custom, etc.).	11. Survival of Socially Fit.
12. { Imitative Selection† [40, 121, 307]. Social Generalization† [121, 310 ff]	12. Imitative Propagation from mind to mind with Social Heredity.	12. Survival of Ideas in Society.

"Certain remarks may be added, to which I give numbers corresponding to those topics in the table to which they respectively relate:

"4, 5, 6. By a singular coincidence M. Delage uses the phrase 'Selection organique' (*Struct. du Protoplasma*, etc., p. 732)to describe Roux's 'Struggle of the Parts.' Seeing that Weismann's 'Intra-Selection (4) was directly applied by him to his interpretation of Roux's 'Struggle,' Delage's phrase is not likely to have currency as a substitute for Intra-Selection. As 'Functional Selection' (5) is a special means of motor accommodation, it is additional, and in a sense subordinate, to Intra-Selection, since it has a *functional* reference.

"7, 8, 9. I do not give a separate heading to Professor Lloyd Morgan's phrase 'Conscious Selection,' since it will be seen that, as he uses it, *i. e.*, in broad antithesis to 'Natural Selection,' it really includes all those special forms of selection in which *a state of consciousness plays the selecting role** (7, 8, 9, 11, 12); it may become ambiguous in reference to cases where *natural selection operates on mental and social variations* (5, 6, 10); and even when applicable, as in 'Sexual Selection' (9),† with respect to the 'means' of the selection, it is still ambiguous with respect to the 'results' of the selection. This last ambiguity, which is brought out in the table (8, 9),‡ makes it desirable to confine the phrase 'Conscious Selection' (if used at all) to cases which result in continuance of what is de-

*I am indebted to Professor Lloyd Morgan for several suggestions utilized in the Table.

† Suggested in this work.

*This, indeed, is still liable to the question as to *whose is the state of consciousness*, giving the difference (both in means and result) seen between 'Artificial' (7) and 'Sexual' (9) selection. It is strange that Professor Morgan makes no allusion (?) to Romanes' earlier suggested term 'Psychological Selection.'

† Lloyd Morgan, *Habit and Instinct*, pp. 219, 271.

‡ The bird 'selects' (sexually) for the sake of the experience, and it is a secondary result that she is also thus 'selected' for mating with the male and so for continuing his attractive characters with her own characters in the offspring.

sirable for consciousness or thought. I have suggested 'Personal Selection (8) for the selection *of* individual persons *by* personal choice, analogous to 'Sexual Selection' (9) in the animal world. Furthermore, Darwin's 'Artificial Selection' should be used, as he used it, with reference only to securing results by induced mating.

"10, 11, 12. In all sorts of so-called 'selection,' *considered as factors in progress from generation to generation, in which the laws of natural selection and physical reproduction do not operate together*, I think it is extremely desirable that we discard the word 'selection' *in toto*, and give to each case a name which shall apply to it alone. The cases of the preservation of individuals and groups by reason of their social endowments do illustrate natural selection with physical reproduction, so I propose 'Social Selection' (10) for that. But in the instances in which either physical heredity is not operative (12), or in which it is not the only means of transmission (11), we cannot secure clearness without new terms; for these two cases I have suggested 'Social Suppression' (11), and 'Social Generalization' (12). The phrase 'Imitative Selection' is given in the table alternately for the latter (12), seeing that the discussions of the topic usually employ the term 'Selection' and use (wrongly) the 'Natural Selection' analogy. Selection may be used also when there is no reference to race-progress (and so no danger of the misuse of the biological analogy); since it then means presumably the 'conscious choice' of psychology and of pre-Darwinian theory."*

J. MARK BALDWIN.

PRINCETON, October 20, 1897.

* It may be well to add that this table is not intended to be altogether exhaustive from the biological standpoint. For example, Professor Minot's 'Post-Selection' and Romanes' 'Physiological Selection' do not fall readily into the scheme. Nor are the different headings in all cases exclusive of one another, *e.g.*, Darwin really included both the cases (I. and II.) of Natural Selection under the single phrase; and justly so, seeing that they illustrate a single principle.

AMPHIBIA VS. BATRACHIA.

I HAVE been much interested in reading the communications of Dr. Gill and Dr. Baur on the above subject, and having developed certain convictions thereon I beg leave to state them. Before proceeding to do this I wish to express my appreciation of the reasonableness of the condition of doubt in which Dr. Wilder finds himself.

Formerly I employed the term *Batrachia*. Later I became inclined to regard *Amphibia* as having superior claims, principally because it has been used and insisted on by many careful writers. I trust that my present views rest upon a better foundation.

In Dr. Baur's communication of July 20th his conclusion is summed up in the following words:

"Three years later Latreille used the Latin names *Reptilia* and *Amphibia* for de Blainville's classes *Reptiles* and *Amphibiens*, and these names ought to be used."

However, it appears to me that he has failed to tell us why they ought to be used; that is, he has not stated the principles which make it obligatory on us to use them. He has only given us an excellent history of the case and his conclusion. We have definite laws governing the formation and use of generic and specific names, but the only law cited by Dr. Baur which applies to appellatives of higher rank is that which deprives of binding authority all vernacular names, even though they may seem to imply the Latin forms. This rule, which most naturalists will endorse, materially clears the ground in the present case. Chéloniens, Ophidiens, Batraciens, and Amphibiens stand on the same footing as Schildkröten, Schlangen, Toads, and Turtles.

It might be supposed that Dr. Baur relies on the law of priority to sustain him, since he is so careful, and properly so, to give the dates of proposal of each of the names employed; but the fact that he rejects *Ranæ* as a name for the frogs, etc., makes it evident that he demands something more. Dr. Gill says that we must be guided by the law of priority in the selection of names.

One thing is very certain, and that is that we cannot rigidly enforce, with respect to the appellatives of higher rank, the same rules that apply to genera. Common usage must and does determine much in the case of the former terms. The law of priority and a desire to

preserve Linnæus' names would probably impel us to overthrow the usurping title *Elasmobranchii* in favor of Linnæus' quite appropriate word *Nantes*. Linnæus' apt *Testacea* has been crowded out of all authority by the upstart *Mollusca*, which, originally ruling over a petty section of heterogeneous elements, now stands at the head of a vast sub-kingdom. Linnæus' beautiful name *Zoophytes* is now replaced by *Cœlenterata*, suggestive of famine. The strict law of priority applied to the term *Reptilia* would result in restricting it to ordinal rank or in worse consequences. Laurenti, 1768, employed it to include Linnæus' *Amphibia* minus the *Nantes*. It then either became a synonym of *Amphibia* or restricted the latter term to the *Nantes*. But the man who at this day attempts to oust *Reptilia* from its position in nomenclature will shed his ink in vain. Furthermore, the contest for the headship of the class embracing the frogs and salamanders lies between *Amphibia* and *Batrachia*. No *Ranæ*, *Ichthyoidea* or *Nudipellifera* need apply.

A word now regarding the use of the word *Amphibia*. Linnæus and some of his disciples included under it not only the reptiles and batrachians, but also various fishes. These being at length excluded, the term was employed for nearly a hundred years by various writers of standing to embrace all the reptiles and ranine and salamandrine forms. In 1825 it seems to have been used for the first time by Latreille, to designate what are now commonly called the batrachians, or amphibians. This is the date given by Dr. Baur, and is most probably the correct one.

In 1804 Latreille recognized the fact that the frogs and salamanders form a natural group, and he called this group the order *Batrachii*. We can hardly suppose that this name will be rejected because of its masculine ending. But if so, the honor of giving the name to the group belongs to Gravenhorst, who in 1807 called it *Batrachia*. But the advocates of *Amphibia* reject Gravenhorst's name, because it was used for the group as an order. Then, must every group be rechristened whenever its rank is changed? I know of no rule of nomenclature requiring this, nor does common usage demand it. Most ichthyologists regard the *Elasmobranchii* as a subclass of *Pisces*. Must those who consider it a distinct class seek a new name? Whenever the word *Mollusca* was applied to the group of mollusks the name dated from that time, even though the group may still have been looked upon as an order of *Vermes*. In the words of Professor Cope (Batrachians N. A., p. 20), 'the rank assigned to such division is immaterial; the idea of the division itself is everything.'

But even in case it were necessary to estimate correctly the value of a group when its name is applied to it, the term *Batrachia* may yet succeed in running the gauntlet. In 1820 Merrem recognized in Linnæus' *Amphibia*, minus the *Nantes*, *two distinct classes*. These he named and adequately defined. The one, *Pholidota*, corresponds to our *Reptilia*; the other he called the *Batrachia*, and it corresponds with the group now so-called. What rule or practice of nomenclature was not complied with by Merrem in this case? This was five years before Latreille restricted the title *Amphibia* to the same class.

If I correctly understand Dr. Baur, he rejects Merrem's name because the latter writer still considered his classes as holding such a relation to each other that they might be brought under the name *Amphibia*, regarded, perhaps, somewhat in the sense of a super-class. Is there any law against this? Such a law would have to be formulated somewhat thus: A class name to be acceptable must originally have been applied to the group regarded as a class, and the author must have entertained opinions now held as orthodox regarding the relationships of his class to other classes.

In conclusion, I will say that, from the evidence now in, it appears to be a very plain case in favor of the defendant, *Batrachia*. I should say that it dates, as a name, from Latrielle, 1804, or from Gravenhorst, 1807; most certainly not later than Merrem, 1820. *Amphibia* has been employed in so many senses that it leads to confusion. It should be reserved for those who may now or hereafter hold there is some special relation between the reptiles and batrachians.

I am sorry to differ with my friends, Dr. Gill and Dr. Baur.

O. P. HAY.

U. S. NATIONAL MUSEUM, September 24, 1897.

THE BRITISH AND AMERICAN ASSOCIATIONS.

TO THE EDITOR OF SCIENCE: Those members of the American Association for the Advancement of Science who went from Detroit to Toronto naturally made comparisons as to the methods by which the affairs of the two organizations were conducted. Permit me, therefore, as one who attended both meetings, to suggest three things which, if properly carried out, will tend to improve, at least to a certain extent, some features in the American Association.

First. The addresses of the President and Vice-Presidents of sections should be in type and ready for publication at the time of the meeting of the Association. By this means the addresses would be available to the daily and scientific press, and every address would be given out at the same time. At Detroit the President's address was not properly reported by any local newspaper, and of the Vice-Presidential addresses only that of Professor Mason was available in pamphlet form.

Second. All papers passed by the sectional committee should go through the hands of a competent press secretary, specially hired for the purpose, preferably a scientific man, who should prepare suitable abstracts of the same for publication. These abstracts should be duplicated by some convenient copying process and given to reporters as desired.

By the combination of these two methods a proper and dignified presentation of the work of the Association would be given to the public, and by using the same for the proceedings the publication of the volume could be begun at once at the close of the meeting. For with the addresses in type and the abstracts in manuscript the volume could be put together and issued as soon as it could be printed.

Third. In lieu of the single public reception given on the first evening of the meeting I would advocate a greater number of social functions at which the members could meet each other. At each meeting of the British Association, besides a reception, there is always a conversazione and a subscription dinner which is given in honor of the retiring President. Would not such gatherings tend to bring the members of our Association into closer relationship with each other? For, after all, it is often the spoken word rather than the formal paper that suggests a line of research or is most fruitful in aiding workers in science.

MARCUS BENJAMIN.

U. S. NATIONAL MUSEUM, November 6, 1897.

SCIENTIFIC LITERATURE.

Boletin del Instituto Geologico de Mexico. Nums. 7, 8 y 9. El Mineral de Pachuca.

Since the Geological Survey of Mexico was placed in charge of Sr. J. G. Aquilera, two or three years ago, the work has been prosecuted with great energy and several quarto bulletins, well illustrated, have been issued. These include a sketch of Mexican geology, studies of rocks and fossils as well as studies of special areas.

The volume named at the head of this note gives the results of detailed examination of a well-known region which, more than once, has attracted the attention of European geologists. There are chapters by nearly all members of the staff, illustrated with 8 large maps and diagrams and 6 quarto plates. These describe elaborately the physiography, general geology, veins, and microscopic character of the rocks as well as matters of economic interest.

The district of Pachuca, not far from Mexico, is almost midway in the Sierra de Real del Monte y Pachuca, on the lower half of the westerly slope and near the southwest border of the Sierra. It embraces about 20 square kilometers and its principal mines are in three ravines which unite to form the Rio de Pachuca. Its output of silver in former years was almost fabulous, but since 1895 it has been practically idle, owing to the flooding of the mines. Now, however, the drainage operations promise to be successful and the geological structure of the region becomes of much interest to Mexicans.

The rocks are all eruptives, though sedimentary deposits, most probably Cretaceous, are shown within a short distance. Andesites, rhyolites and basalts are the forms, and of each there occur numerous varieties in texture, color and composition. The chapter on the general geology by Aguilera and Ordoñez gives much detail respecting the macroscopic features of these rocks and their chronological relations. The authors feel justified in concluding that

there have been three periods of eruption since the Middle Tertiary: (1) That of basic andesites, terminating in outpourings of rhyolite. (2) That of spongy porous rocks and ashes, marking the beginning of a tranquil period. (3) That of the basalts, continuous with Quaternary volcanic eruptions in various parts of the Sierra. The second period was marked by circulation of thermal waters in the fissures leading to the deposition of quartz with the sulphides.

The intimate structure of the veins, their variations in relation to the adjacent rocks and to each other, as well as the distribution of ores, are considered in a chapter by the same authors. Sanchez contributes a mathematical discussion of the fracture systems, arriving at practically the same conclusions with Daubree. Ordoñez gives results of investigation of the rocks microscopically, which are illustrated upon a plate. Other chapters by Sanchez, Rangel and Castro discuss the more purely economic features, exploitation, drainage, machinery and metallurgical methods in such a way as to be serviceable to those for whose special advantage they were written.

The volume is creditable alike to the authors and to the Minister of Internal Affairs, who has encouraged the expansion of the work.

J. J. STEVENSON.

Geologic Atlas of the United States, Folio 34. Buckhannon, West Virginia, 1897.

This folio consists of a descriptive text, a topographic map, a sheet of areal geology, one of economic geology, one showing structure sections, and finally a sheet giving a generalized section and table of synonymy. The authors are Joseph A. Taff and Alfred H. Brooks.

The quadrangle comprises an area of 931¼ square miles and for the most part is located in the Appalachian coal field near the center of West Virginia, between latitudes 38°, 30′ and 39° and longitudes 80° and 80°, 30′. It embraces portions of Lewis, Upshur, Randolph, Webster, Braxton and Barber counties. The southeastern corner of the quadrangle lies in the district of parallel ridges which characterize the western border of the Great Valley, or central division of the Appalachian province. Rich and Mill, Back Fork, and Point mountains, which attain elevations or more than 4,000 feet, are the principal border ridges here mapped. From these elevated ridges the surface, an inclined peneplain, falls away toward the northwest, down to an elevation of near 1,700 feet. Six rivers have their sources within this quadrangle, West Fork of Monongahela, Buckhannon, Middle Fork, Valley, Little Kanawha, and Elk, all belonging to the Ohio drainage. These rivers, having their powers of corrasion augmented by the elevated and tilted surface of the country, have dissected the once nearly first country by deep, narrow channels.

The stratigraphy column makes a section of about 4,600 feet of rock. Sixteen hundred feet of interstratified Devonian sandstone and shale are divided nearly equally between the Jennings and Hampshire formations. Of the Lower Carboniferous there are about 1,100 feet, of which less than 100 feet is Pocono sandstone; 350 feet of Greenbrier limestone, and 650 feet of red shale, brown sandstone and conglomerate, making the Canaan formation. The remaining 1,900 feet comprises the coal measures known in this folio as the Pickens sandstone, Pugh formation, Upshur sandstone and Braxton formation, which are composed of conglomerate, sandstone and shale with beds of coal.

The structure of this district is typical of the two provinces which it includes. In the southeastern portion, east of Rich Mountain, the structure is that of the folded region of Great Valley, which is characterized by long parallel anticlines and synclines with north-southwest axes. West of Rich Mountain the typical Cumberland Plateau structure prevails. Here the strata are slightly inclined and gently folded.

The only product of economic importance is coal, of which there are seven workable beds. Two of these occur in the Pickens sandstone, three in the Upshur sandstone and two in the Braxton formation. The coals are from two to six feet thick. They have not been worked on a commercial scale, because other areas of productive coal lie between this field and the seaboard and nearer to large centers of coal consumption, both north and west.

On the economic sheet of the folio structural contours at intervals of 100 feet are represented by white lines. These, as drawn, represent the inequalities of the upper surface of the principal coal bed in the Upshur sandstone. The thickness of the strata being known, it is evident that the position of any other coal seam or bed may be determined from this datum plain.

Laboratory Manual of Inorganic Chemistry. By RUFUS P. WILLIAMS, in charge of the Chemical Department of the English High School, Boston. Boston, Ginn & Co. 1896.

This book, which is intended especially for use in elementary schools, is arranged so that each page is devoted to a separate topic. The alternate pages are left blank for notes and the experiments are unusually full of minute directions. This minuteness of directions may be well in the case of one who is working alone and can use the book to aid him in difficulties; but when working under the eye of the instructor it is questionable whether such close attention to details given in the book and, as in this case, working by rules is not apt to make the student too dependent, instead of teaching him to observe for himself and to devise, to a certain extent, the methods of work he shall follow in each experiment. The free use of symbols in other than equations is especially objectionable in the early stages of the study, as the student becomes impressed with the idea that proficiency in the use and manipulation of chemical symbols is the thing to be acquired and not the principles of the subject. Difficulties encountered and overcome by the ingenuity of the student are a great incentive and give him confidence in his own powers. After taking up in order the common non-metallic elements, the author gives the usual methods of separating the members of the different groups of metals. These are given without any preliminary study of the different members of the groups, which would enable one to understand the principles upon which the separations are based and must be entirely mechanical in their nature. No text-book is recommended for use with this laboratory guide, and while it can probably be used with good results in many cases it must be with the constant attention of the teacher and the elimination of some features, especially the part relating to the separation of the metals.

J. E. G.

Elements of Chemistry. By RUFUS P. WILLIAMS, in charge of the Chemical Department of the English High School, Boston. Boston, Ginn & Co. 1897.

The title of this book is rather a misnomer, as the author has gone beyond the capacity of an elementary student and has introduced much matter which would only bewilder a beginner in the subject. As he says in the preface, 'the division of matter into coarse and fine print enables a choice to be made' according to the needs of the class. He is a strong advocate of graphic methods of representing compounds, and 'and many topics—such, for example, as valence, etc.—have been treated in quite an original manner.' On turning to this chapter we find that he represents valence graphically 'by using cubical kindergarten blocks with small screw-eyes and hooks' to represent the bonds and their method of attachment. Before studying the simplest element he instructs the student in the methods of writing symbols and finding molecular weights by rule. The subject, omitting the theoretical part, is treated in a very thorough manner for an elementary book; but the arrangement, especially that of the non-metals, is not as systematic as it might be. The latter part of the book contains an account of some common organic substances and a chapter on the chemistry of fermentation and of life.

J. E. G.

Congreso Internacional de Americanistas. Actas de la Undecima Reunion, Mexico, 1895. Mexico, 1897. 1 Vol. Pp. 576.

The previous volumes of the International Congress of Americanists all contain some valuable articles and all a good deal of trash. In both these respects the present Compte-rendu resembles its predecessors. Why people who pretend to be scholars still want to publish articles showing that the name of the Atlas mountains is derived from the Nahuatl 'Atlan;' that the Otomis are related to the Chinese; that the cross of Palenque is a proof of Buddhistic

worship in America; that the 'Toltecs' spooked around Central America; that the fables of the Aztec story-tellers can be assigned local existence, and the like, is hard to understand; and why a scientific society spends its money in publishing such stuff would be more inexplicable did we not all appreciate the importance of not offending the genial members of such reunions.

Fully half this volume is taken up with such padding and with second-hand material. Rather than occupy the reader's time with a discussion of it, it will be more profitable to mention some of the really valuable contributions to American studies, which are between the covers of the nearly six hundred pages.

Naturally we look for special attention to the Nahuatl language. Nor are we disappointed. The Rev. Hunt Y. Cortes, distinguished by his previous studies in this tongue, offers a number of specimens of the classical idiom, with excellent analyses and grammatic observations; Don José Maria Vigil called attention to the ancient Mexican songs still extant, and Don Mariano Sanchez Santos, an accomplished Nahuatl scholar, gave translations of several of them. Lauro Castanedo sent copies of a few old religious manuscripts in a dialect, evidently corrupt, of the ancient tongue. Other linguistic memoirs are presented, one from Dr. Pimentel, on the present classification of the Mexican languages; a catalogue of periodicals published in North American native tongues, by Sr. Cesare Poma; a valuable grammatical sketch of the Guaraouno tongue, by M. L. Adam; two by M. Raoul de la Grasserie, on the Auca and the Yunga; a comparison of the Huasteca and Nahuatl, by Alvarez y Guerrero, and several rather wild flings at the derivations of some native names.

The only contribution of moment offered to the study of the hieroglyphic writing was a paper by Dr. Nicolas Leon on the employment of a script of the kind, of course devised by their European teachers, among the Otomis, in a period long after the Conquest. We learn from this memoir that the spiritual fathers did all they could to keep the Indians in ignorance of white civilization, and thrashed them if they tried to learn Spanish!

The papers on the ancient monuments are moderately full. Señor Rodriguez describes the pyramid of Tepozteco at length, and Mr. H. S. Jacobs, in a somewhat flowery style, runs over the cliff-dwellers and the 'dead empires, the wonderful evidence of prehistoric life, to be found in Mexico!'

Some minute questions in Mexican history are elucidated, and Mr. Thomas Wilson advances various reasons showing the great antiquity of man in America. Professor Mariano Barcena submits again the evidence for the prehistoric man of the valley of Mexico, our old friend, the 'Hombre del Peñon,' about whom our departed colleague, Professor Cope, became skeptical in his latter days.

There are some other articles in the volume, good in the way of compilations; one on the media of exchange of ancient Mexico, by Mr. J. W. Bastow; one on the ancient commerce of Yucatan, by the late Bishop Carrillo Ancona; on the medical knowledge of the Aztecs, by Alatriste de Lope; and others of minor importance.

Although the scientific value of the volume may be disappointing, the foreign associates were unanimous in their sincere recognition of the generous hospitality they received from the Mexican government and citizens; and it is very creditable to the Committee of Publication that the volume has appeared thus promptly, while the report of the Congress in Stockholm, in 1894, to employ a Gallicism, still 'lets itself be waited for.'

D. G. BRINTON.

Totem Tales. W. S. PHILLIPS. Chicago, Star Publishing Co. 1896. Pp. 326.

The present book pretends to be a collection of myths from the coast of the North Pacific Ocean. The author says: "The stories contained in this little volume under the title of 'Totem Tales' are the result of careful study and research among various tribes of Indians of the Northwestern Pacific Coast. The Indian peculiarity of narration is kept, as nearly as possible, consistent with an understandable translation from the native tongue into English." If it were not for these claims the book might pass unnoticed, but since the author's expressions might be taken seriously it may be well to

sound a note of warning. Nothing can be less Indian than the words in which the tales are couched, nothing more misleading than the illustrations which represent the Indians of the coast as living in tepees and dressed in the style of Indians of the plains. The few sketches of Indian masks and paintings are given fanciful interpretations. Most of the stories are highly modified versions of stories from the region between Columbia River and Alaska, but the author has also introduced the Sedna legend of the Eskimo of Baffin Land (see Sixth Annual Report Bureau of Ethnology, p. 583 ff.) under the title 'Cawk, the Beaver's Daughter.' The figures representing the thunderbird (pp. 286 ff.) have been taken from the Tenth Annual Report of the Bureau of Ethnology (p. 483) and belong to a variety of tribes. As a representation of Indian life and thought the book is entirely misleading.

FRANZ BOAS.

SOCIETIES AND ACADEMIES.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular November meeting of the New York Section of the American Chemical Society was held on the 5th, at the College of the City of New York. A paper on 'Corrected Assays' was read by E. H. Miller, and on the 'Chemistry of Formaldehyde in Disinfection with Exhibits' by Dr. E. J. Lederle.

Apparatus was exhibited for the production of formaldehyde in house disinfection, and an active discussion followed on its chemical properties, methods of estimating strength of solutions, effects of impurities, etc. It was stated that none of the so-called 40% solutions contain more than 33 to 36% of formaldehyde, and on account of the numerous impurities the specific gravity is no guide to the strength of the solutions. Its combination with glue was said to be perfectly stable, and if once thoroughly dried, perfectly insoluble.

A paper on the 'Chemistry of Substance used in Perfumery' was announced for the next meeting, and an interesting exhibit of natural and synthetic products is anticipated.

DURAND WOODMAN,
Secretary.

NEW YORK ACADEMY OF SCIENCES—SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

THE Section meets bi-monthly at the Mott Memorial Library. The first meeting of the fall was held Monday evening, October 25th. Professor Cattell presented a report from the pen of Professor A. C. Haddon, of England, on Anthropology at the Toronto meeting of the British Association, and Dr. A. Hrdlicka reviewed the work in Anthropology and Psychology at the American Association.

Dr. Franz Boas and Dr. Livingston Farrand made a preliminary report of their work during the summer on the Jesup expedition sent out by the Museum of Natural History.

Their work was mainly among two of three tribes in the western part of British Columbia. Many interesting details were brought out with reference to tribal organization, language, customs and traditions. Attention was called to the rapid changes going on as a result of their location upon government reservations.

The general plan of the work undertaken by the Museum was outlined by Dr. Boas. It will extend over a period of years and will include an exhaustive study of the tribes on the northeastern coast of Asia as well as all the remaining tribes on the northwestern coast of America.

The next meeting of this section of the Academy will be held on the last Monday in January.

C. P. BLISS,
Secretary.

NEW YORK UNIVERSITY.

SCIENTIFIC JOURNALS.

American Chemical Journal, November.—'The Action of Carbon Dioxide upon Sodium Aluminate and the Formation of Basic Aluminium Carbonate,' W. C. DAY: Evidence in favor of the existence of a carbonate of aluminium. 'Aliphatic Sulphonic Acids,' E. P. KOHLER: General methods of preparation of the unsaturated aliphatic sulphonic acids. 'The Dissociation of Electrotypes as Measured by the Boiling-Point Method,' H. C. JONES and S. H. KING. 'On Diacyl Anilides,' H. L. WHEELER, T. E. SMITH and C. H. WARREN: Crystallographic study. 'Synthesis of Hexamethylene

Glycol Diethyl Ether and and other Ethers from Trimethylene Glycol,' A. A. NOYES. 'On the Chloronitrides of Phosphorus,' H. N. STOKES: Isomeric series of compounds. 'Preliminary Paper on the Composition of California Petroleum,' C. F. MABERY. 'On the Solubility of Ammonia in Water at Temperatures below 0°C,' J. W. MALLET. 'Note on a Somewhat Remarkable Case of the Rapid Polymerization of Choral,' J. W. MALLET. This number also contains obituary notices of Victor Meyer, Paul Schutzenberger and C. Remegius Fresenius.

J. ELLIOTT GILPIN.

Journal o the American Chemical Society, November.—'The Solubility of Stannous Iodide in Water and in Solutions of Hydriodic Acid,' S. W. YOUNG. 'On Iodostannous Acid,' S. W. YOUNG. 'A Comparison of Various Rapid Methods for Determining Carbon Dioxide and Carbon Monoxide,' L. M. DENNIS and C. G. EDGAR. 'The Electrolytic Determination of Cadmium,' DANIEL L. WALLACE and EDGAR F. SMITH. 'On the Reactions between Mercury and Concentrated Sulphuric Acid,' CHARLES BASKERVILLE and F. W. MILLER. 'On the Determination of Fat and Casein in Feces,' HERMAN POOLE. 'The Principal Amid of Sugar Cane,' EDMUND C. SHOREY. 'The Influence of Antiseptics on the Digestion of Blood Fibrin by Pepsin in a Hydrochloric Acid Solution,' CHARLES F. MABERY and LEO GOLDSMITH.

The Botanical Gazette, November.—'Notes on the Fecundation of Zamia and the Pollen Tube Apparatus of Ginkgo,' HERBERT J. WEBBER: In continuation of previous papers calls attention to some of the peculiar phenomena which occur during the process of fecundation and to features in the development of the pollen tube apparatus of Ginkgo, and the origin of the centrosome-like bodies. 'North American Species of Amblystegium,' LELLEN STERLING CHENEY: Describes sixteen species, of which ten are found both in Europe and North America, one in North America and Japan, and five exclusively in North America. 'Vernation of Carya,' WILLIAM WHITMAN BAILEY. 'Abnormal Leaves and Flowers,' T. D. A. COCKERELL. 'Stomata on the Bud Scales of Abies Pectinata,' ALEXANDER P. ANDERSON.

The American Geologist, November.—'On Streptelasma profundum (Owen), S. Corniculum Hall,' F. W. SARDESON. 'The Koochiching Granite,' ALEXANDER N. WINCHELL. 'On the magnetite belt at Cranberry, North Carolina, and Notes on the Genesis of this iron ore in general in crystalline schists,' JAMES P. KIMBALL. 'Diceratherium Proavitum,' J. B. HATCHER. 'The Fisher Meteorite, Chemical and Mineral Composition,' N. H. WINCHELL.

NEW BOOKS.

Traité de zoologie. Edited by RAPHAEL BLANCHARD. Fascicle XI., Némertiens, Louis Jouben, pp. 54, with 35 figures. Fascicle XVI., Mollusques, H. Paul Pelseneer, pp. 187 with 157 figures. Paris, Schleicher Frères. 1896.

Traité de zoologie concrete. IVES DELAGE and EDGARD HÉROUARD. Tome I. La Cellule et les Potozoaires. Paris, Schleicher Frères. 1896. Pp. xxx+584.

L' Année Biologique. IVES DELAGE. Paris, Schleicher Frères. 1897. Pp. xlv+732.

La vie mode de movement. E. PRÉAUBERT. Paris, Felix Alcan. 1897. Pp. 310.

Popular Scientific Lectures. ERNST MACH. Translated by THOMAS J. MCCORMACK. Chicago, Open Court Publishing Co. 1897. Second edition, revised and enlarged. Pp. 382. $1.00.

Teaching as a Business. C. W. BARDEEN. Syracuse, N. Y., Bardeen. 1897. Pp. 154.

Industrial Freedom. DAVID MACGREGOR MEANS. New York, D. Appleton & Co. 1897. Pp. vii+248. $1.50.

Birdcraft. MABEL OSGOOD WRIGHT. New York and London, The Macmillan Co. 1897. Pp. 317. $2.50.

The Elements of Electric Lighting. PHILIP ATKINSON. New York, D. Van Nostrand Company. 1897. Pp. vi+275. $1.50.

Social and Ethical Interpretations in Mental Development. JAMES MARK BALDWIN. New York and London, The Macmillan Co. 1897. Pp. xiv+574. $2.60.